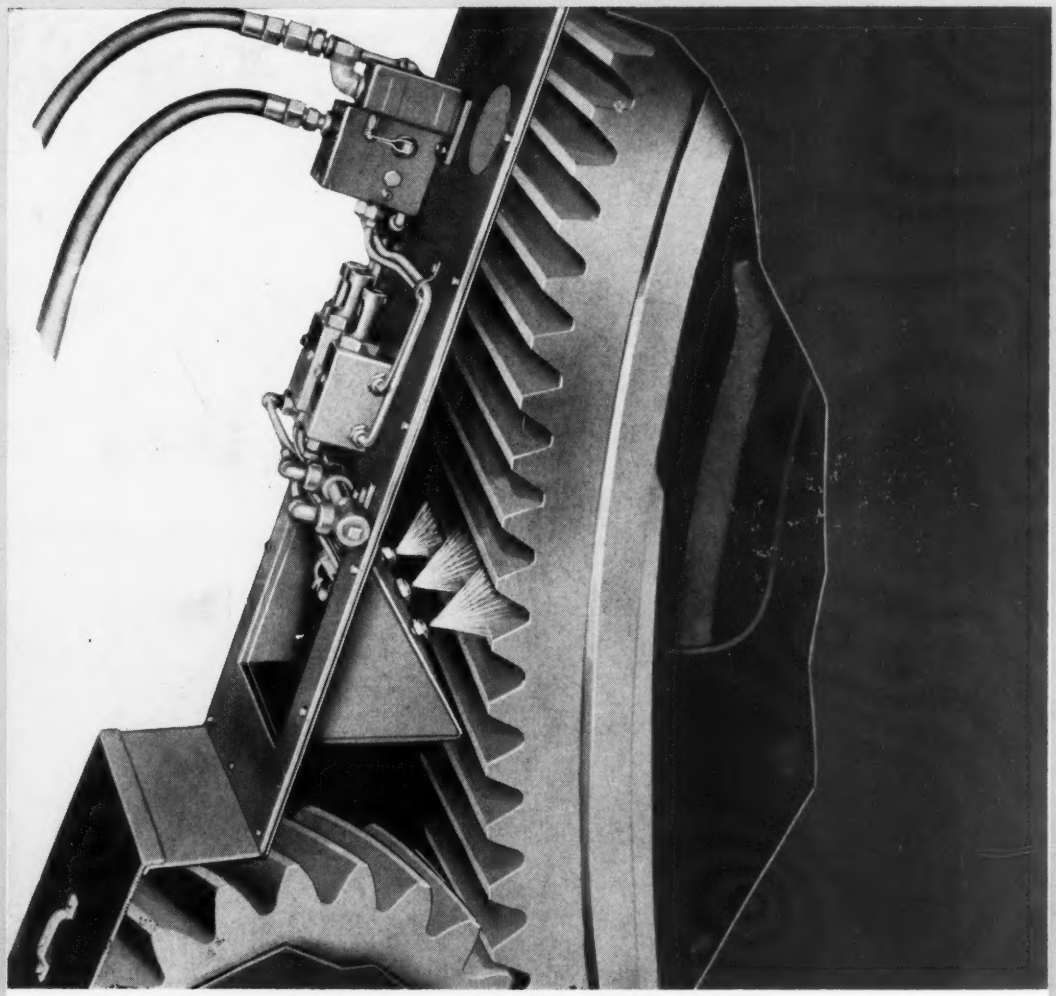
Vol. 15, No. 10 October, 1959

LUBRICATION ENGINEERING

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE



SPRAY LUBRICATION OF GEAR TEETH (see page 398)

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

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Since 1876 the Brooks Oil Company has been a specialty manufacturer of petroleum products for the industrial lubrication field.

Among the best known products manufactured by Brooks are LEADOLENE-KLINGFAST lubricants. They are particularly adaptable to open, enclosed and semi-enclosed gears.

Compounded to meet rigid specifications . . . having the following desirable characteristics:

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Adhesiveness. Affinity for steel and other metals . . . restricting creep, leakage and losses.

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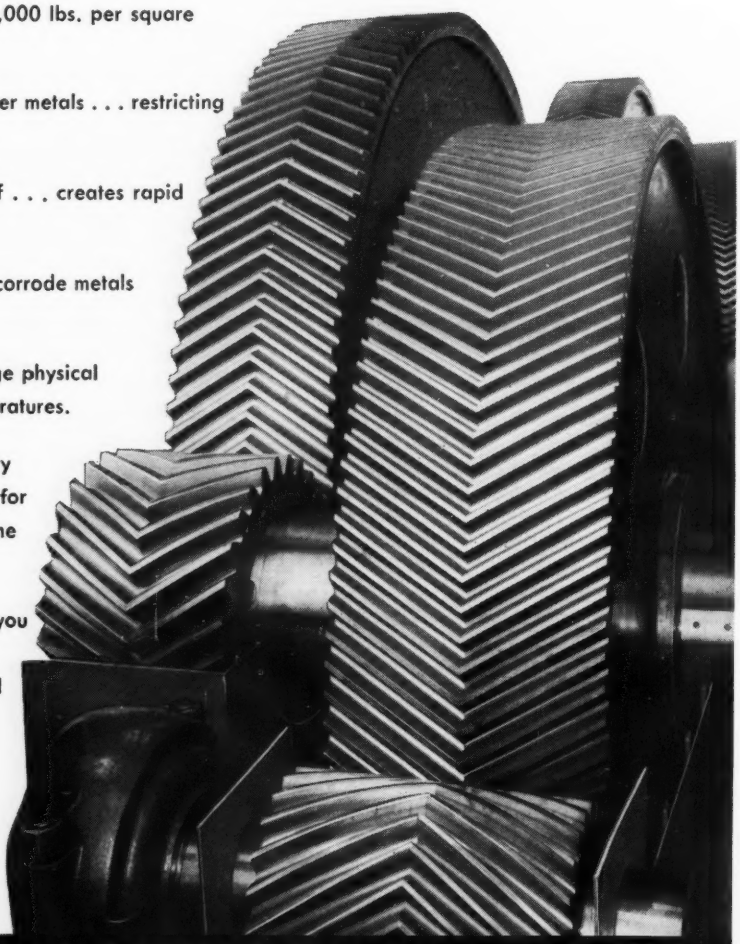

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Volume 15, No. 10
October, 1959

Lubrication Engineering

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

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AMA Releases R&D Budget Survey

Research and development budgets in almost 600 U. S. corporations are 12 per cent higher this year than 1958's record outlay, according to a survey recently released by the American Management Association. A total of 64 per cent of the firms studied increased their budgets for the development of new products and processes, eight per cent were unchanged, and 28 per cent reduced budgets. Last year's survey showed R&D budgets to be only four per cent higher than in 1957.

The accompanying table shows the results of the survey as reported by the AMA.

AMERICAN MANAGEMENT ASSOCIATION
ANNUAL ANALYSIS OF RESEARCH & DEVELOPMENT BUDGETS—1959

INDUSTRY GROUP	NUMBER OF COMPANIES REPORTING TOTAL	NO. UP	NO. SAME	NO. DOWN	AVERAGE 1959 R&D BUDGET INCREASE OVER 1958 (%)	1958 R&D BUDGET % OF 1958 SALES
Aircraft	12	7	2	3	6.7	3.3
Automobiles	5	5	—	—	32.1	2.8
Chemicals	154	103	8	43	11.3	4.3
Electrical Machinery	40	27	3	10	23.8	4.1
Engines & Turbines	5	3	—	2	2.8	2.0
Fabricated Metal Products	38	19	5	14	5.7	1.7
General Industrial Machinery	19	15	2	2	16.3	7.0
Metalworking Machinery	3	2	—	1	21.7	3.2
Miscellaneous Machinery & Parts	9	3	3	3	(—2.5)	3.1
Miscellaneous Manufacturing	68	44	6	18	9.6	2.8
Nonferrous Metals	21	11	2	8	12.4	1.3
Paper	26	17	4	5	11.6	.9
Petroleum Refining	19	12	5	2	1.4	1.2
Service Machinery	1	1	—	—	6.0	1.9
Steel	12	5	1	6	2.4	1.1
Textiles	10	3	1	6	10.3	1.4
Transportation Equipment	4	2	—	2	7.5	2.2
TOTALS	582	371	48	163	12.1%	3.2%

Synthetic Lubricant Manual Published

An Air Force manual of non-optical, non-instrumental techniques for the analysis of synthetic lubricants, greases, and their additives has been published by the Office of Technical Services, U. S. Department of Commerce. It is especially designed for laboratories which lack either modern analytical equipment or personnel trained in the use of the equipment.

Also just published is an Air Force report which rates ten military fuels and six lubricants as the most promising for use in nuclear-powered aircraft. The reports are:

Development of Schematic Analytical Procedures for Synthetic Lubricants and Their Additives: Part 4—Laboratory Manual for the Analysis of Synthetic Lubricants, Greases and Their Additives. F. S. Bonomo and J. J. E. Schmidt, Denver Research Institute for Wright Air Development Center, U. S. Air Force. July 1957. 296 pages. (Order PB 131414 from OTS, U. S. Department of Commerce, Washington 25, D. C., $6.) Most of the methods use simple wet chemical manipulations, or such techniques as adsorption or partition paper or column chromatography. Detailed explanations are provided, including drawings and photographs of equipment where necessary. The methods are patterned after the format of Federal Test Method Standard No. 791 and, in most instances, can be modified or otherwise adapted for use with newly developed compounds. (Part 1 of this series, PB 111856, April 1955, 223 pages, $5.75; and Part 3, PB 131063, April 1957, 56 pages, $1.50, were previously released and are still available from OTS.)

The Behavior of Fuels and Lubricants in Dynamic Test Equipment Operating in the Presence of Gamma Radiation. M. Z. Fainman and others, Inland Testing Laboratories Division, Cook Electric Company for Wright Air Development Center, U. S. Air Force. March 1958. 198 pages. (Order PB 151701 from OTS. U. S. Department of Commerce, Washington 25, D. C., $3.) Relative ratings of the ten military fuels and six lubricants which show the best performance characteristics for potential use in nuclear-powered aircraft are presented. The major objective of this program was to evaluate the performance in radiation environments of fuels, hydraulic fluids, and lubricants developed by various Air Force contractors. A total of 79 fuels and 41 lubricants were studied with dynamic test machinery in combined environments of radiation and high-temperature. Results of the tests point out the importance of assessing the effects of mechanical, thermal, and radiation stresses simultaneously. Such results often differ from those obtained by alternate exposure to the environment separately. The machines used in the tests, their purposes, and the design modifications required are described. More than a hundred graphs, photos, and tables are used to present the resultant data.

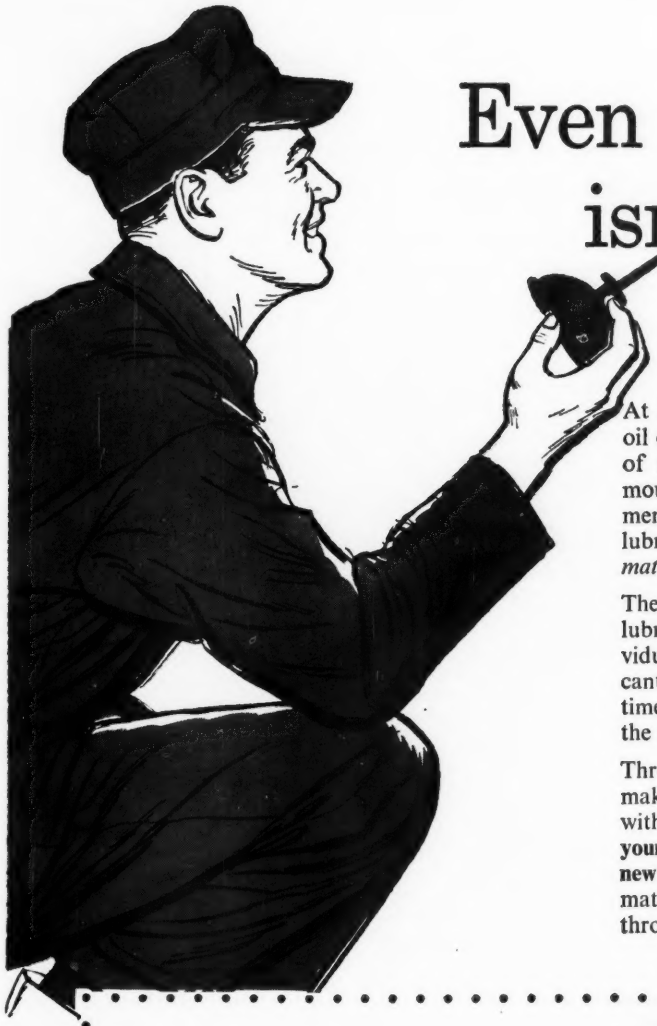
NSPA Releases Glossary of Terms

The National Fluid Power Association, 5595 N. Hollywood Ave., Milwaukee 17, Wisc. has released it's first report, of an annual series, indicating progress in the compilation of a comprehensive Glossary of Terms and Definitions for Fluid Power. The report is being distributed to technical associations and societies, educational institutions, U. S. Department of Commerce and other organizations interested in fluid power. The NFPA Terminology Committee is currently studying over a thousand fluid power terms and more than 1,300 definitions. Material is being collated from the American Society of Lubrication Engineers and other technical societies and associations. On completion of this project the work will be presented to the American Standards Association.

New Company Forms in Chile

Mobil International Oil Company announces the formation of a new company in Chile which will be jointly owned by the Mobil organization and the Chilean

(*Cont. on p. 388*)



Even the best man isn't automatic!

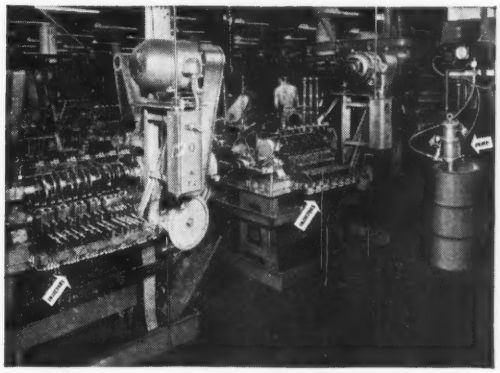
At his very best, no maintenance man, armed with an oil can, is able to supply precisely controlled lubrication of modern complex production machinery. Today's mounting maintenance costs and big production investments require that you be *sure* of supplying the right lubricant, in the right quantity, at the right time *automatically*. You *can* be with Lincoln Centralized Systems.

These Power Lubrication Systems apply viscous or fluid lubricants through sealed lines to all bearings on individual machines or automated production lines. Lubricant is supplied under uniform pressure at predetermined time intervals . . . unerringly . . . automatically . . . while the machines are operating.

Throughout the country, plants, mills and mines are making tremendous cost savings and production gains with these modern, low-cost Lincoln installations. **Call your nearby Lincoln Distributor . . . and write for Lincoln's new brochure, "A Report To Management",** which dramatically proves how spectacular savings can be effected through modern lubrication methods.

By installing a time clock-controlled Lincoln Centralized Lubrication System on an existing battery of 18 cam milling machines, one of the nation's largest automobile manufacturers was saved from having to buy a complete new battery of machines.

RESULT: *Increased production, 80% reduction of rejects, and 50% reduction of lubricant consumption.*



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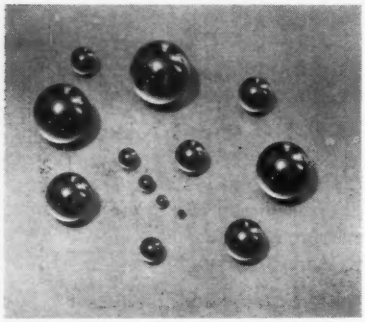
NEW PRODUCTS

HIGH SPEED STEEL BALLS AVAILABLE FROM STOCK

Precision balls of high speed steel (M-10, vacuum melted) are now available. They are carried in stock in 13 standard sizes 1/16 in. to 1/2 in. These balls are made to precision tolerances of plus-or-minus .000010 in. on size, .000010 in. on sphericity, and have a surface



finish of two microinches rms. They are ideal for bearings and other components operating at temperatures up to 900 F. A price list giving specifications and stock sizes is available on request from Industrial Tectonics, Inc., Ann Arbor, Mich.

LEAK PROOF CHECK VALVE

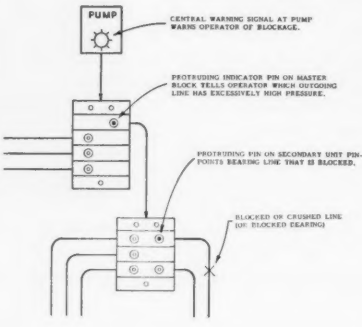
The Quality Control Corp. has announced a new hydraulic & pneumatic check valve called Quality Seal that reportedly has been thoroughly tested for maximum safety, performance and durability. The new valve features a compact design and is exceptionally small and light in weight. It is designed to allow full flow at operating pressures up to 3,000 psi, with a minimum pressure drop, and to provide quick opening and positive closing. A new technique incorporating a seal ring with a dual seating action is used to guarantee a leak proof valve at both high and extremely low pressures and chatterless, vibration free performance. Wrench portion of body is made square to differ from standard AN and MS fittings. Standard sizes are available for Tube Connection ¼ inch to 2 inches. Full information may be obtained by writing directly to the company, Quality Control Corp., 7315 W. Wilson Ave., Chicago 31, Ill.

O-RINGS OFFER ADVANTAGES

A new line of standard O-rings made of Rulon, a modified Teflon, has been introduced by the Dixon Corp. of Bristol, R. I. Because of the characteristics of Rulon . . . fluorocarbon containing reinforcing agents which greatly increase wear resistance, decrease deformation under high loads and high temperatures, and cut thermal expansion by ½ . . . these O-rings reportedly offer many performance advantages. When installed in rotating applications these seals are claimed to have no tendency to twist or snake since their self-lubricating characteristics eliminate drag. Tests show these O-rings have less tendency to extrude at high temperatures and high pressures than regular Teflon O-rings. Rulon O-rings are recommended by the company for static and dynamic application such as piston seals, valve seals, flange gaskets, tube fitting gaskets, and many other jobs.

INDICATOR FINDS TROUBLE IN CENTRALIZED SYSTEM

Trabon Engineering Corp., Solon, Ohio, has developed a new trouble indicator for progressive type centralized oil and grease systems. The new Reset Indicator, available in a wide range of spring pressures (from 250 to 2500 psi), pinpoints a blocked line condition in the centralized lubrication system. When a blocked condition is cleared, the indicator pin will


PUMP
CENTRAL WARNING SIGNAL AT PUMP WARNS OPERATOR OF BLOCKAGE.
PROTRUDING INDICATOR PIN ON MASTER BLOCK TELLS OPERATOR WHICH OUTGOING LINE HAS EXCESSIVELY HIGH PRESSURE.
PROTRUDING PIN ON SECONDARY UNIT PINPOINTS BEARING LINE THAT IS BLOCKED.
BLOCKED OR CRUSHED LINE (OR BLOCKED BEARING)

automatically return to normal position. Available in ⅛ inch NPT and ¼ inch NPT sizes, the Reset Indicator is screwed into the alternate outlet or test plug tap of each outgoing line from the master and secondary distributors of the progressive Type M or MX lubricating system. Write for Bulletin #PH 79-5.

LUBRICANT IN TUBES USED FOR GREASE-GUNS

A new multi-purpose lubricant, offered in tubes for grease-gun application, is being introduced by Pennzoil South Penn Oil Co., Oil City, Pa. through some 300 distributors. Claimed to be a lubricant that "can be used on practically anything that moves," the lithium-base grease has the highest possible melting point, provides complete rustproof security on the road or in storage, and offers maximum adhesion to metal under all weather and operating conditions.

FAST-FLOW METER ACHIEVES SMOOTH DELIVERY

To meet the modern challenge of increased speed of delivery and larger tank truck operations, Granberg Corporation announces a new fast-flow truck meter with rated capacities up to 600 gpm, for both pump and gravity service. The "K" Meters are available in sizes of 1¼

inches to six inches with rated capacities of 40 gpm up to 600 gpm. They reportedly achieve smooth, non-pulsating delivery by means of a five-blade rotor that maintains accuracy at all viscosities. Another outstanding design feature of the new meter is its long life-expectancy.

(*Cont. on p. 390*)

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Wasting time and profits searching for the right gear oil for your machinery? Atlantic has the key to your problem, because our long experience has made us familiar with your lubricating needs. We've developed the products that can do any lubricating job to perfection . . . at low cost . . . for every wheel that turns in industry.

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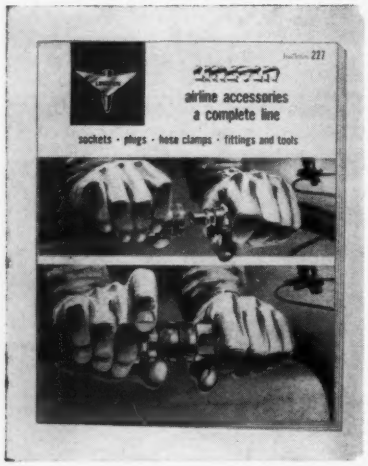
PITTSBURGH, PA.
Chamber of Commerce Building

In South America
Atlantic Refining Company of Brazil, Rio de Janeiro

PRODUCT LITERATURE

CATALOG PUBLISHED OF AIR SUPPLY LINE ACCESSORIES

A catalog illustrating and describing its newly-expanded line of air supply line accessories has recently been published by Lincoln Engineering Company, Division of The McNeil Machine & Engineering Company, St. Louis. Included in Catalog #227 are sockets, plugs, hose clamps, fittings and tools—all of which are interchangeable with most standard makes. Copies of the catalog may be obtained from Lincoln Engineering Co.



SURVEY BULLETIN PRESENTS HYDRAULIC SYSTEMS

Twenty new hydraulic system control units for aircraft and missile operations are presented in a survey bulletin published by Whittaker Controls division of Telecomputing Corp. The bulletin is divided into five areas—Shear Seal Valves, Hydraulic System Components, Hydraulic Selector Valves, Poppet Relief Valves, and Shut-Off Valves. Some of the special illustrated units featured, include an auto-pitch actuator, with an electronic mechanism sensing incipient stall; A stainless steel high pressure, helium relief valve; A solenoid pilot-actuated sleeve selector valve, and a dual solenoid, pilot-actuated spool valve. Also illustrated are a manually operated three-way, two-position rotary selector valve, and a helium, fluorine gas and liquid fluorine poppet relief valve. Copies of "Hydraulic Controls Bulletin HC2.20" may be obtained by writing to Whittaker Controls, Division of Telecomputing Corp., 915 N. Citrus Ave., Los Angeles 38, Cal.

DATA SHEET DESCRIBES NO-LEAK PILOT

Engineering Data Sheet FR 108 describing their recently developed no-leak two way pilot operated solenoid valve has just been made available by Fluid Regulators Corporation, 313 Gillette St., Painesville, Ohio. The data sheet lists complete operating specifications, engineering data, and dimensional information. It also features a typical flow curve illustrating the very low pressure drop for this valve. The valve described is designed for use with hydraulic fluid MIL-0-5606 and similar liquids. Temperature range is —65F to +275F. For use in 3000 psi systems. The valve operates on 0.185 amp 25 volt DC.

FILTER MEDIA SELECTION CHART OFFERED

New literature prepared by Purolator Products, Inc. guides the selection of proper engineering materials and filter media for given types of corrosive conditions. Prepared in booklet form, the chart lists filter media for varying concentrations of more than 125 corrosive agents. Primarily, the chart narrows down the choice of filter materials and the company recommends the booklet as a basic reference source. The booklet—designated PUR-66D—lists corrosive agents varying from acetic acid to zinc chloride; concentration percentages; temperatures; and filter media of metallic, plastic, or other type design. For a copy of PUR-66D, write Purolator Products, Inc., Rahway, N. J.

CATALOG DESCRIBES MECHANICAL PACKINGS

A new 64-page catalog containing information about the complete line of Johns-Manville mechanical packings, has been published. Text throughout is supplemented by a variety of photos, illustrations and specification charts and tables. Each packing style carries a symbol to help the user quickly identify the media that the particular packing will best serve against. Cross-section photos displaying the material in such a way that prospective users may see the total product more readily are included in the catalog. A Packing Selection Chart helps the user relate his particular operation conditions (rotary, reciprocating, valve, etc.) to the most suitable packing construction style. A comprehensive section on how to determine the causes of packing trouble is offered as a further aid. Another feature of the catalog is an easy-to-scan table of contents plus a numerical and alphabetical indexing page on the inside back cover. The front cover carries a 3½" × 2" blank space for distributors' imprint or attachment of a calling card. The catalog, Form PK-131A, can be obtained from Johns-Manville district offices or from company headquarters at 22 East 40th St., New York 16, N. Y.

COUPLINGS ILLUSTRATED

Features of "15 Series" connect-quick disconnect valved couplings are described in a four-page catalog published by Snap-Tite, Inc., Union City, Pa. The line is reportedly designed for no-spill service in accordance with military specifications for use in airborne and ground hydraulic systems. Spillage, air inclusion, pressure drop, and envelope for the couplings are all within specification requirements. Cutaway drawings, complete dimensional data, and selections of end threadings for six sizes of the couplings are included in the illustrated catalog. Various accessory items also are illustrated and detailed. Copies of the catalog, No. 280B, may be obtained by writing.

LAB SURVEY ON FILM LUBRICANTS AVAILABLE

A twenty-page brochure has just been released covering the comparative values of moly, synthetic graphite, natural graphite, chemical EP, and non-additive lubricants. Over fifty composite charts in this comprehensive survey compare moly against the other film lubricants on the Falex, Timken, Shell 4-Ball, and kinetic friction testing machines. The study examines the lubricants in relation to their frictional properties, wear reducing abilities, film endurance, load capacities, and temperature reducing abilities. The results show the superiority of moly in boundry, oscillating, and slow speed operation; (and the effectiveness of moly under high speed testing.) The report covers the addition of moly and the other solid and chemical additives to greases, oils, synthetics, and bonded coatings. Copies of the report are available from Bemol, Inc., 131 State St , Boston.

He's mopping up the mess for the last time

At a leading aircraft research center, high-frequency vibration caused severe oil leakage from hydraulic lines servicing a huge wind tunnel. Many man-hours each month were wasted cleaning up the basement floor underneath, even though drip pans were used extensively.

Now, after a change to a Suntac oil, the vibration-caused leakage has been reduced to a point where "mop-up" is not needed. Hydraulic-fluid consumption has been cut by 4000 gallons a year. That's economy! That's Sun quality—the best economy of all.

If your plant is troubled with a leaky system, a Suntac antileak hydraulic oil can save you money, too. Ask your Sun representative to show you the Suntac desk-top demonstration, or write direct to SUN OIL COMPANY, *Philadelphia 3, Pa., Dept. LE-10, In Canada: Sun Oil Company Limited, Toronto and Montreal.*

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AMERICA'S ONLY DOMESTIC PRODUCED DEGRAS

Always Uniform—Always Available

ANALYSIS

Specific Gravity 20°C./20°C.	0.940 - 0.960
Free Fatty Acid (as Oleic)	10.0 - 14.0%
Moisture	0.5 - 1.2%
Ash	0.1% max.
Melting Point	36.0° - 44.0°C.
Flash Point	540°F. approx.
Fire Point	570°F. approx.
Saybolt Viscosity at 210°F.	155 seconds approx.
Iodine Value (Hanus)	20.0 - 35.0
Saponification Number	100.0 - 116.0
Penetration at 77°F. unworked	150 - 180 mm/10
worked	340 - 370 mm/10
Color ASTM (Max.): 10% 4.5	30% Greater than #8

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LUBRICATION IN THE NEWS

(*Cont. from p. 382*)

oil products marketing firm, Compania de Petroleos de Chile, better known as Copec. Mobil International is a division of Socony Mobil Oil Company, Inc.

The new entity, Mobil Oil de Chile, Ltda., is believed to be the first oil company in this country owned in equal parts by a U. S. and a Chilean firm. The Chilean partner, Copec, which will be 25 years old next year, is owned entirely by Chilean private capital and is the largest marketer of petroleum products in the country.

Mobil Oil de Chile is now building a $975,000 lubricant-blending plant in the Pacific coast city of Vina del Mar, one of the best known sea resorts in Latin America. In order to harmonize with the architecture of this city, the facade of the lubricant plant has been designed to look like a modern private home. It will have interior and exterior lawns and flower gardens, and the tanks and pipes will be painted to merge with the landscape.

The blending plant, scheduled to begin operations late this year, is being built entirely by Chilean construction firms. It will have an initial capacity of 78,000 barrels a year, which can easily be doubled. Its fourteen storage tanks, now about 80 per cent complete, will hold 63,000 barrels of blending stocks. A ten-inch pipeline will be laid 400 feet out to sea and connected to buoys, where ocean-going tankers will discharge blending stocks.

Products to be blended at the new plant will include automotive, industrial, aviation, and marine lubricants. Mobil Oil de Chile's importation of packaged lubricants will virtually cease when the plant goes on stream. The installations will be staffed and manned 100 per cent by Chileans.

Symposium on Gas-Lubricated Bearings

The Office of Naval Research will hold a symposium on Gas-Lubricated Bearings in Washington, D. C., on October 26-28, 1959. This symposium will provide an introductory over-all examination and critical review of research and development pertinent to gas-lubricated bearing design technology. It will be the first meeting devoted exclusively to broad international scientific coverage of gas-lubricated bearings.

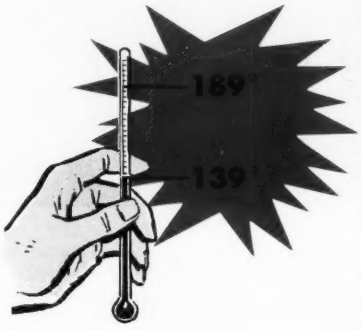
The symposium will attempt to cover all aspects of the subject-theoretical and experimental research, design, production, and application. Papers have been invited from authoritative contributors to the field in the United States, Great Britain, France, Germany, Austria, Japan, and Rumania.

All interested persons are invited to attend. Inquiries should be addressed to Power Branch, Office of Naval Research, Institute Laboratories for Research and Development, Philadelphia 3, Pa.

Lubrication Problems in Control Cables Being Explored

High temperature lubrication problems in servo-mechanism control cables are being explored by E. N. Klemgard, head of the Industrial Research Division's chemical engineering research section, for the Teleflex Corporation of North Wales, Pa.

The control mechanisms are being developed by the Teleflex organization for use in nuclear power reactors, guided missiles and jet aircraft engines. Present alloys being used for these control cables tend to gall and fail at high temperatures.



At Gould Paper Company Bearing Temperatures Reduced 50° F*

Automatic, centralized Micro-Fog Lubrication was installed early in 1957 by Gould Paper Co., Lyons Falls, N. Y., on the dryer section of this paper machine. It has lowered the average operating temperature of all 86 half bearings (9½" dia. x 12") from 189° F to 139° F. Two other similar machines were also converted by this company to Micro-Fog — a total of 368 bearings of all types.

The magic of Norgren Micro-Fog *provides these additional benefits at Gould:*

1. Elimination of frequent bearing failures.
2. Elimination of the cost of hand oiling and block grease replacement.
3. Elimination of fire hazard from dripping lubricant.
4. No product contamination.
5. 66% reduction of lubricant consumption.
6. Perfect lubrication for all bearings.

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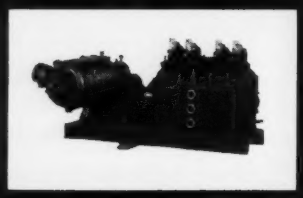

HOUDAILLE INDUSTRIES, INC. Manzel
315 Babcock Street
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Specialists in metering pumps and lubricators since 1898

NEW PRODUCTS

(*Cont. from p. 384*)

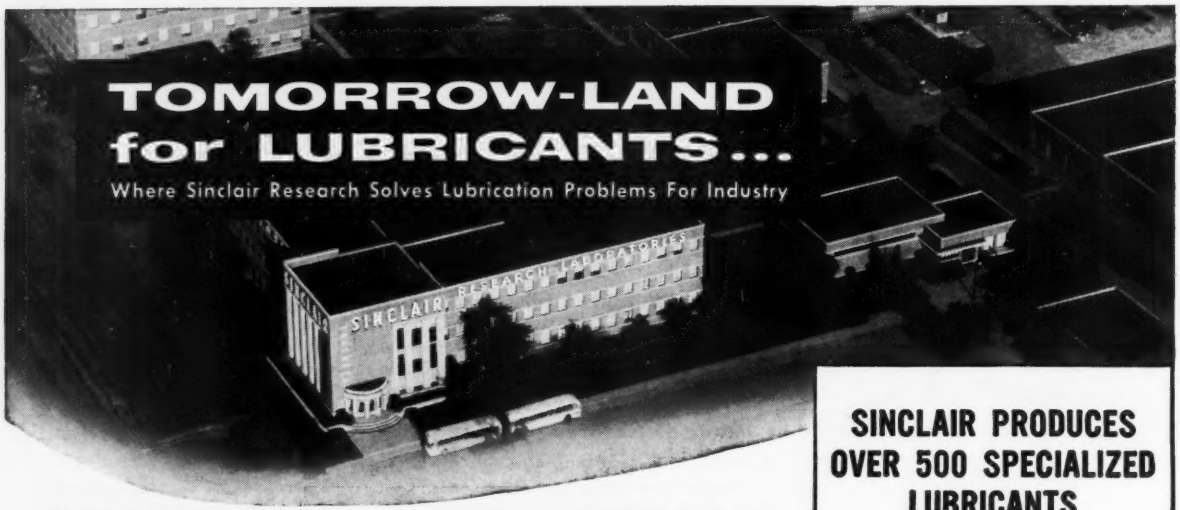
OIL PROTECTS AGAINST RUST

Lehigh Chemical Company of Chestertown, Md. is marketing a synthetic instrument oil which is reported to offer a significant increase in temperature range and lubricant life over customary petroleum-based lubricants.

Anderol L-281 Instrument Oil is a medium viscosity diester oil engineered specifically for use in precision instruments. Physical characteristics of the synthetic lubricant include an evaporation rate so low that it remains fluid up to 100 times longer than ordinary instrument oils. The temperature range of this new lubricant is from —75 F to 350 F. It is said to be completely compatible with ordinary lubricants, and to offer penetration comparable to the finest penetrating oils. Suggested applications for Anderol L-281 include clocks and watches, precision bearings, pneumatic systems, hydraulic systems, electrical control boxes, electric motors, parking meters, and all types of instruments and timers. It is available in pint, quart or gallon cans and five or 55 gallon drums. For additional information, write direct to Lehigh Chemical Company, Industrial Lubricants Division, Chestertown, Md.

SYSTEM ALLOWS LUBRICATION OF OVERHEAD HOISTS . . . FROM FLOOR

Safe-Lub, a new system for lubricating overhead hoists from the floor, has been introduced by the Detroit Hoist and Machine Company, 8201 Morrow Street, Detroit 11, Mich. Consisting of tough, flexible nylon tubing, the system carries lubricant from a fitting mounted on the pendent control directly to the trolley wheel bearings on the hoist. It permits easy lubrication of many hoists by one man in a matter of minutes.



Located at Harvey, Illinois, is one of the most extensive installations of its kind in the world—Sinclair Research Laboratories. These facilities are an important part of Sinclair's investment in the future. Here is where Sinclair engineers and chemists work to develop new products and improve the quality of existing ones. At these famous laboratories were developed the Sinclair lubricants now solving difficult problems in all branches of industry. If you have a special lubrication problem, write today to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y.

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SINCLAIR PRODUCES OVER 500 SPECIALIZED LUBRICANTS for
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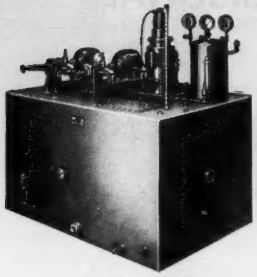
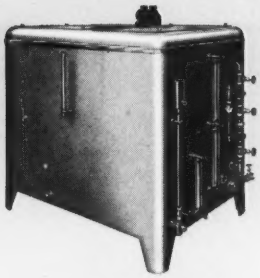
and many other applications



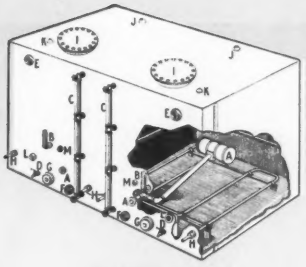
SPACE SAVING LUBRICATION SYSTEM

Figure 829 Self-Contained Lubricating Units offer a complete oil circulating and filtering system . . . compactly designed with filter, pumps, pressure tank, piping, alarms, gauges, etc.



OIL CONDITIONER

Figure 832-P — Filters and conditions turbine and other low viscosity, high demulsibility oils . . . without aeration, turbulence, heat or the use of moving parts.



RECEIVING AND STORAGE TANKS

Figure 363 — Two-Compartment Storage Tank permits precipitation of dirt and water from one batch while other batch circulates through system. Capacities 300 to 8,000 gallons.

Figure 360 — Receiving Tank receives dirty oil by gravity . . . precipitates dirt and water before pumping to filter. Capacities 100 to 6,000 gallons.

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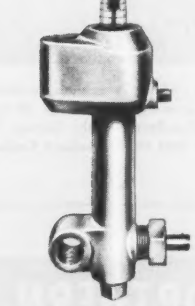
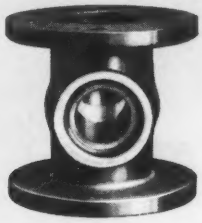


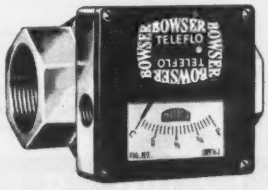
SIGHT FEED OILER

Figure 818 — Pressure-type oiler features location of indicator outside the liquid body making it ideal for use with dark liquids.



FLOW SIGHTS

Double window flow sights for vertical installation on gravity flow lines. Flow is clearly visible . . . glasses do not cloud.



TELEFLOW INDICATOR

Figure 815 offers easy reading graduated dial for close approximation of liquid in flow. Vane type indicators also available.

Bowser cooperates by furnishing complete data for any specific installation or catalogs for engineering files . . . send coupon.

MAIL TO: Date _____

BOWSER, INC.
1300 E. Creighton Ave.
Fort Wayne, Indiana

Gentlemen: Please send prices and detailed information on:

- ☐ Figure 829 Lube System
- ☐ Receiving & Storage Tanks
- ☐ Flow Sights
- ☐ Figure 823-P Oil Conditioners
- ☐ Figure 818 Oiler
- ☐ Teleflow Indicator

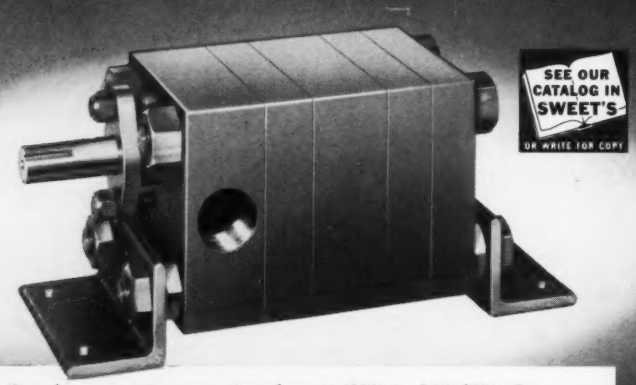
(Attach to your letterhead for quick response.)

1958-59 Membership Awards

C. L. Willey, ASLE Executive Secretary, examines plaques awarded to the sections which showed the greatest percentage of membership increase in the year 1958-59. Winners were: Group I, Dallas-Fort Worth; Group II, Connecticut; Group III, Cleveland. This is the second straight year that the Cleveland Section has won the membership contest by an overwhelming margin.

NORTHERN NITRALLOY PUMPS

Lube oil, seal oil and fuel oil pumps for compressors and engines



Complete range in pump sizes from ¼ GPM to 146 GPM. Pressures to 2000 PSI. Proven in thousands of installations and backed by 50 years of engineering and production experience, Northern Steel Block Nitralloy Rotary Gear Pumps are unexcelled for precision manufacture, accurate assembly and dependable, long life operation. Write for free catalog and engineering data.

NORTHERN ORDNANCE, INCORPORATED

Subsidiary

NORTHERN PUMP COMPANY

MINNEAPOLIS 21, MINN.

PERSONALS

James F. Coogan has been appointed advertising manager for Texaco Inc. and Raymond Apy, sales promotion manager. Both will report to John H. Childs, newly-appointed general manager of advertising and sales promotion.

K. B. WOOD, JR.

H. Follett Hodgkins, Jr. is returning to his position as vice president of Rollway Bearing Company, Inc., Syracuse, New York, after a year's study of advanced management techniques and procedures under a Sloan fellowship at Massachusetts Intitute of Technology.

W. H. FOWLER, JR.

W. H. Fowler Jr., Manager, Industrial Sales, Pure Oil has retired after 29½ years service. Fowler served as secretary-treasurer of ASLE from 1952 to 1955.

Appointment of David B. Eden to the newly created position of director of distributor sales was announced recently by SKF Industries, Inc. In his new capacity, Eden will be responsible for all domestic distributor sales and the operation of field warehouses.

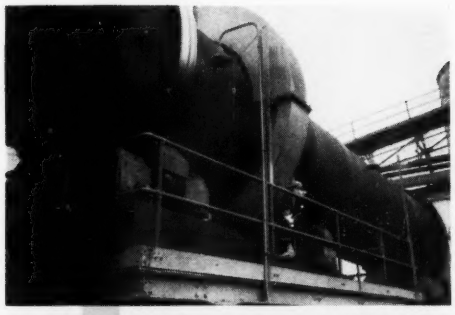
S. S. RICKLEY

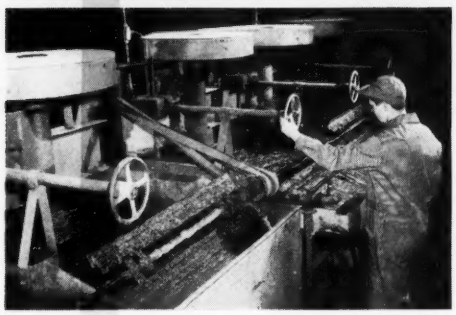
The assignment of Thomas W. Morrison as director of engineering and research was also announced by SKF. In his new post, Morrison takes over active direction of the ball and roller bearing manufacturer's Engineering Division and Research Lab.

Kenneth B. Wood, Jr. was given the position of manager of lubricant development at the Climax Molybdenum Company, A Division of American Metal Climax, Inc. His responsibilities will be to develop new applications and markets for Molysulfide lubricants.

R. C. Brock, industrial division manager, was elected vice-president in charge of the Joseph Dixon Crucible Company's industrial division. Brock will supervise sales and marketing activities.

Samuel S. Rickley has been announced chief engineer of the Morgoil Bearing Department of the Morgan Construction Company.





Where heat or wet conditions are a problem . . .

the answer– use greases made with

BARAGEL*

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BAROID CHEMICALS, INC.

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5993 *BARAGEL is a registered trademark of National Lead Company for organic ammonium montmorillonites.

Big Hit for Decca --DARINA

Decca Records, Pinckneyville, Illinois use Shell Darina Grease 2 for the entire plant's grease lubrication.

When Decca Records opened its Pinckneyville plant late in 1957, they required a high-temperature grease for their hot plasticizing mills. After testing many greases under actual plant conditions, Shell Darina Grease 2 was selected. In fact, Darina® proved so successful in its original application that Decca now uses it throughout the plant.

Darina Grease 2 is a premium-quality, multi-purpose grease with exceptional stability in extended high-temperature applications. It offers excellent resistance to corrosion and oxidation. It gives outstanding performance (compared with conventional soap-type greases) for long-time wet or dry applications at temperatures as high as 350° F.

For complete data on Darina Grease, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California. In Canada: Shell Oil Company of Canada, Limited, 505 University Avenue, Toronto 2, Ontario.

SHELL DARINA GREASE

the multi-purpose, high-temperature grease

SHELL

Lube Lines

by A. F. Brewer*

THE DETRIMENTS OF SLUDGE

Seeing is believing is generally accepted as a self-evident fact. What one can see with respect to lubrication, however, is often not the whole story. It is only the visual side as indicated by oil flow in a sight feed bullseye or the oil level gauge. Complex chemical changes may be occuring within the oil in the lubricating system to shatter the belief that the oil is providing effective lubrication. Sludge—the result of these chemical changes—may be at work in the dark like a veritable termite.

The detriments of sludge formation must be thoroughly understood by management because the nature of the lubricating oil is involved, and management normally is responsible for selecting the type of oil. The physical and chemical changes which cause sludge are related to the way in which the oil is refined, how effectually it can resist oxidation, and its ability to separate rapidly from water. While the causes may be complex the detriments are clear, as related to impairment of oil circulation with possible inability to maintain an adequate lubricating film in bearing clearances and on the sliding surfaces. Thus if the oil is subject to overload, the bearing temperatures in a turbine, for example, may run dangerously high.

Sludge formation is progressive. Oxidation of certain of the unsaturated hydrocarbon components in the oil, starts the reaction. It can be affected by certain metals present and their catalyzing influence. Unfortunately oxidation cannot be entirely prevented, although it can be retarded by inclusion of certain additives which will make the oil as resistant as possible to oxidizing effect. Increase in viscosity is one of the indications that oxidation is going on and that sludge is beginning to form in the shape of temporary and then permanent emulsions; accelerated by moisture especially under high temperatures. At first the resultant sludge will be soluble in the oil but as the latter is subject to further oxidation the sludge will become insoluble, gummy and sticky. The oil will darken in color and the chemist will note decided increase in the neutralization number. In an engine oil some petroleum sludges can be kept in a suspended state throughout the body of the oil by inclusion of a suitable dispersive type of additive which, coupled with one of detergent type, will aid materially in keeping the engine clean during the operating life of the oil.

The lubrication engineer is fully conversant with the detriments of sludge and the operating procedures to prevent it from becoming a definite menace to engine or machine performance. Management can cooperate in curbing this menace, attacking the problem at the source through an appreciation of the value of additives as a means of assuring greater chemical stability and resistance to oxidation especially in the presence of heat. Laboratory inspection of used oil at regular intervals will indicate changes in the nature of the oil and impairment of its lubricating value. Rate of change and rapid rise in the neutralization number which indicates the organic acid content of the oil, is a warning of active formation of such acids and predicts that oxidation is progressing at a dangerous rate.

Petroleum oils are of complex hydrocarbon nature, the various fractions which go to make up the whole having boiling points of comparatively wide range. The science of petroleum chemistry is directed towards segregating these fractions in the course of refinement in order to remove those of most extreme boiling point. This is called close fractionation. At the same time study is given to removal of the most easily oxidized components—the unsaturates and reactive aromatics. Sludge dispersion ability may be a natural property to some extent according to the oil: it is a most prevalent characteristic in residual oils but is less prevalent in distillates.

Being forewarned as to the detriments of sludge, its formation and how the petroleum chemist proceeds to control this formation in a finished lubricating oil, Management can become a partner in this control in service by selecting the oil on a proven performance basis. Since it is neither economical nor desirable to place an oil in service without adequate assurance that it will perform satisfactorily, manufacturers of lubricants have perfected evaluation procedures by which quality can be controlled throughout the entire course of manufacture and by which the suitability of the finished oil can be predicted in accordance with the prospective operating conditions, temperature ranges and means of protection. When the plant lubrication engineer is invited by management to consult with the lubricant manufacturer's representative, with quality and service durability as the primary objectives, there normally will be the most favorable reaction upon production and low-cost maintenance.

* Consultant and author "Basic Lubrication Practice."

250,000 Power Tools per year with Cities Service Pacemaker T

Porter-Cable, one of the world's largest manufacturers of portable wood-working tools, has long known the value of quality in a lubricant as well as in a power tool. Each piece of equipment made by Porter-Cable is carefully pretested before manufacture and then continually tested for years after its original appearance on the market. It is this kind of thoroughness that led to Porter-Cable's choice of Cities Service Pacemaker 300 T as the hydraulic oil to power their Fostermatic Screw Machines and Landis Grinders.

But Cities Service Pacemaker T is more than a hydraulic oil . . . it is a multi-purpose line of lubricants suited for many applications. Porter-Cable also uses Pacemaker 300 T for lubricating valves in the plant's compressors. Pacemaker T can be used to lubricate bearings, diesel engines, electric motors, generators, reduction gear drives, turbines and in circulating systems.

Pacemaker T is available in various viscosities to give you one line of quality lubricants that can save costly warehouse space by simplifying your inventory . . . cut maintenance costs and extend equipment life. These oils have high viscosity index, excellent heat resistant properties and are chemically fortified against oxidation, corrosion, rust formation and foaming.

Contact your nearest Cities Service office and an experienced Lubrication Engineer will call to make specific recommendations for your plant on the use of Pacemaker T. Or for further information, write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Porter-Cable Machine Company
Syracuse, New York

Porter-Cable Research Engineer testing engine for new lawnmower the company will produce soon. All new products undergo extensive research and testing before production.

Backbone of Production Line is Automatic Screw Machine. Pacemaker T gives outstanding performance as hydraulic medium in these machines as well as in Landis grinders and as a general lubricant!

Vol. 15, No. 10

Lubrication Engineering

Fifteen years ago the American Society of Lubrication Engineers was created and dedicated by its founders to "advance the knowledge and application of the science of lubrication." The intervening years have seen this vision take root. ASLE, the only existing engineering society devoted exclusively to lubrication, is now firmly established. In fact, the Society now enjoys the reputation of being the agency for the exchange of all types of information on lubrication.

but what of the future?

The Society's journal, LUBRICATION ENGINEERING, has undergone many changes since the first issue. Each change has been aimed at the production of a better technical magazine and each improvement with the view of making it the unquestioned leader in its field. It is now regarded as *the* medium for keeping abreast of new developments in the field of lubrication.

Last year saw the introduction of ASLE Transactions. This new publication makes it possible to publish more information more quickly. To pave the way for the continued growth of the Society, a revised Constitution was adopted by the Board of Directors last April and is now awaiting ratification by the members. The changes made in the Constitution provide for a more equitable representation for all members, and are designed to promote further development of the Society.

This does not mean that we can now sit back and let matters take their course. There is still far too much to be done and far too little appreciation of the importance of proper lubrication to permit any such point of view. Fifteen years of achievement can be viewed with pride but the limitless expanse of the future lies before us. Here is where our history will be made.

Calvert L. Willey,
Executive Secretary

Modern Techniques For Spray Lubricating Industrial Gearing

This paper covers 18 years of development and progress with spray lubricating equipment for open gearing. The paper starts with the origination of the idea and discusses the step-by-step sequence that transformed the original idea into the broadly accepted modern centralized spray lubricating systems known today.

Pointed out in the discussion of the subject is the fact that the outstanding feature of a centralized spray lubricating system is that air and lubricant can be controlled and applied in exactly the quantities required. This substantially reduces the cost of lubricating open gearing and at the same time provides better lubrication for this type of gearing.

After an insight on spray system development problems the paper concludes with a short discussion of present trends and a glimpse of what is ahead for this type of equipment.

by E. J. Gesdorf

The Farval Corporation,
Cleveland, Ohio

It appears that the imagination and initiative of some steel mill lubrication engineers know no limits. This fact is illustrated by an interesting chain of events prior to 1950, which led to the development of modern automatic industrial gear spray systems, such as illustrated in Fig. 1.

In the past, open gears were lubricated by swabbing, brushing, pouring, dipping and dripping. All of these methods of application had disadvantages in throw-off, drippage, lack of uniform distribution, excessive consumption and expenditures beyond an economical standard in clean-up and disposal labor.

The first step in the improvement of lubricant application methods for open gearing came approximately 18 years ago, when a well-known steel mill lubrication engineer in the Gary district conceived the idea of applying lubricant to open gearing by the spray method. From the start this method was received with enthusiasm, particularly in the heavy industries where large numbers of open gear installations were in service and the lubrication problem was acute and costly.

Presented before the 14th Annual Meeting of the American Society of Lubrication Engineers, April, 1959, Buffalo, New York.

The first attempts at spray lubrication for open gearing were made with conventional paint-spraying and roof-coating equipment. Because of the bulky, cumbersome nature of this equipment, along with the personal injury hazards involved in dragging air and lubricant hose lines around and through moving machinery, improvements in the original idea came rapidly.

A five-pound portable lubricant spray outfit was then introduced by a lubricant supplier as the next step in this development to simplify the operation and promote the sale of his open gear lubricants. This equipment did bring about improvement in the way of work simplification but it did not eliminate the necessity of a man climbing around the moving gears and exposing himself constantly to the possibility of serious injury. Fig. 2 shows portable spray equipment being used to lubricate wire rope.

Attempts were then made to lubricate gearing with permanently installed nozzles. The nozzles were connected to a common air supply line and to a common lubricant supply line. The air line was pressurized by a source of compressed air while at the same time the lubricant supply line was pressurized by an air-powered lubricant pump operating on a standard drum of gear lubricant. Air and lubricant were ejected simultaneously from the nozzle tips where atomization of the lubricant took place. This type of installation is shown in Fig. 3.

Control of the system was accomplished by turning on and turning off the air pressure. This could be done with a manually-operated air valve or auto-

Fig. 1. Automatic gear spray system on rod mill drive.

matically with the use of a solenoid operated air valve. It can readily be seen that with this arrangement the quantity of lubricant sprayed onto the gearing is related to the length of time the pump is permitted to operate. The discharge from an air-powered pump, however, is not constant as it will vary with the load. On this particular application, the load varied with temperature changes due to the drastic effect the temperature had on the consistency of the lubricant. The result was that the quantity of lubricant sprayed per system cycle was highly variable and at times reached dangerously low limits.

In addition to the difficulties in control of the quantity of lubricant sprayed for a given pumping time, further problems were encountered in obtaining balanced distribution throughout the system. The nozzles closest to the pumping unit or source of pressure discharged considerably more lubricant than the nozzles located at the extremities of the system. This condition resulted in over-lubrication of some gears while other gears showed a tendency to run dry.

After the lubricant supply line to the nozzles had been pressurized and the lubricating cycle completed, compression in the lubricant line caused the nozzles to bleed for a considerable period of time. This made an unsightly, wasteful condition, as in some cases much more lubricant dripped into the pits than was sprayed on the gearing.

The problems encountered with spray systems of the permanently installed nozzle type pointed more and more to the need for precise control over the quantity of lubricant and air supplied to the individual nozzles in the system.

A considerable amount of the early development work with spray systems was done by a lubricant supplier located in the Chicago area. As time went on, the lubricant supplier found himself getting deeper and deeper into the dispensing equipment field. With this realization, a centralized lubrication system manufacturer was consulted and encouraged to develop equipment that would not only spray conventional gear lubricants but would offer precision control over the quantities of air and lubricant discharged.

After some study and experimental work, the first centralized spray lubricating system was introduced in the year 1950. This system offered accurate adjustable control over the quantity of lubricant sprayed, along with automatic air valving for each nozzle. The outstanding feature of this development was that air and lubricant could be controlled and applied in exactly the quantities required, thus making it possible for the first time to substantially reduce the cost of lubricating open gearing and at the same time provide better lubrication for this type of gearing.

An illustration of the original centralized spray lubricating system is shown in Fig. 4. While the illustration shows a simple, manually-operated pumping unit with a single measuring valve and spray nozzle, the system had considerable flexibility in that it could be arranged to serve a large number of gears by adding additional measuring valves and nozzles. Also, the system could be easily converted to automatic operation.

In the original design, the lubricant measuring valve and air control valve were contained in a simple assembly, as shown in Fig. 5. This achieved neatness and compactness from a design viewpoint. However, it was soon learned from field experience that improvements were necessary and desirable. First of all, corrosion problems were encountered in the mechanism as the result of the moisture contained in the compressed air that passed through the air control valve. With some additional experience, especially on large gearing, it was discovered that greater discharge quantities of lubricant per cycle were essential.

After considerable study, a decision was made to

Fig. 2. Five pound portable lubricant spray equipment.

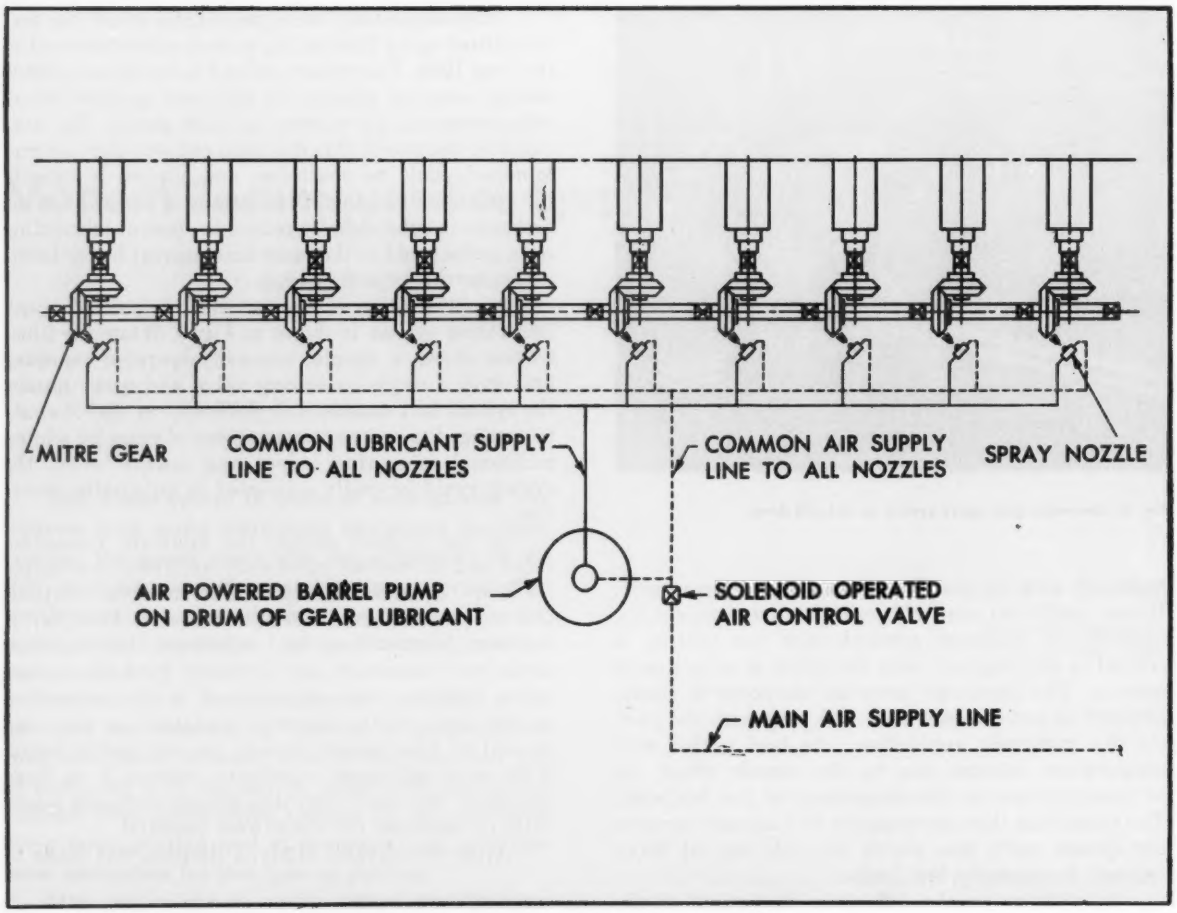
MITRE GEAR
COMMON LUBRICANT SUPPLY LINE TO ALL NOZZLES
COMMON AIR SUPPLY LINE TO ALL NOZZLES
SPRAY NOZZLE
AIR POWERED BARREL PUMP ON DRUM OF GEAR LUBRICANT
SOLENOID OPERATED AIR CONTROL VALVE
MAIN AIR SUPPLY LINE

Fig. 3. Permanently Installed nozzles on a mill table.

separate the air control valve from the measuring valve and a design was produced as shown in Fig. 6. This improvement put new life into the automatic spray lubricating system business. Elimination of the early problems, along with increased flexibility of the spray systems brought about broad acceptance of this new approach in the open gear lubrication field. In the new design the air control valve was made exclusively of anti-corrosion materials to combat moisture. Furthermore, the new design permitted the use of various capacity standard measuring valves in keeping with the requirements of the gear being lubricated.

Fig. 7 shows a modern gear spray lubricating system. The chief objective in this illustration is to give an exact idea of the type of equipment we are discussing. At this time it should be pointed out that the spraying of lubricant with this type of equipment is on an intermittent basis. The centralized spray lubricating system could correctly be termed a gear-coating device because its chief function is to maintain a film of lubricant on the gear teeth.

Many problems were still ahead that had to be solved individually. A large number of the users of open gearing were accustomed to using heavy viscous gear lubricants that had to be heated to reduce the consistency for application. On one of the early centralized spray lubricating systems installed on a gear and pinion set in an eastern cement plant, an attempt was made to apply a lubricant having a viscosity of 1200 to 1300 ssu at 210 F. The approach here was to use a drum warmer and wrap and steam trace all pipe lines to maintain the lubricant at high temperature for the purpose of reducing viscosity and making the lubricant pumpable. A photograph of this installation is shown in Fig. 8.

So much difficulty was encountered on this application that the customer finally consented to using one of the newer open gear lubricants whose consistency had been reduced with a diluent to make the material pumpable without the assistance of heat. The success of spray-lubricating open gearing in this plant from this time on was so phenomenal that extensive systems were installed to serve the gear and pinion sets

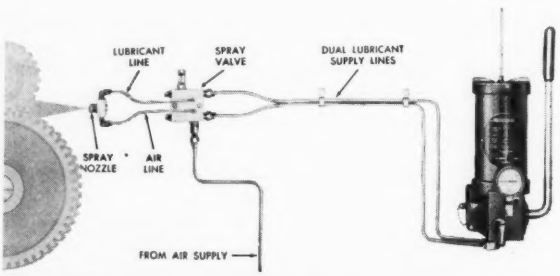

Fig. 4. Original centralized spray lubricating system.

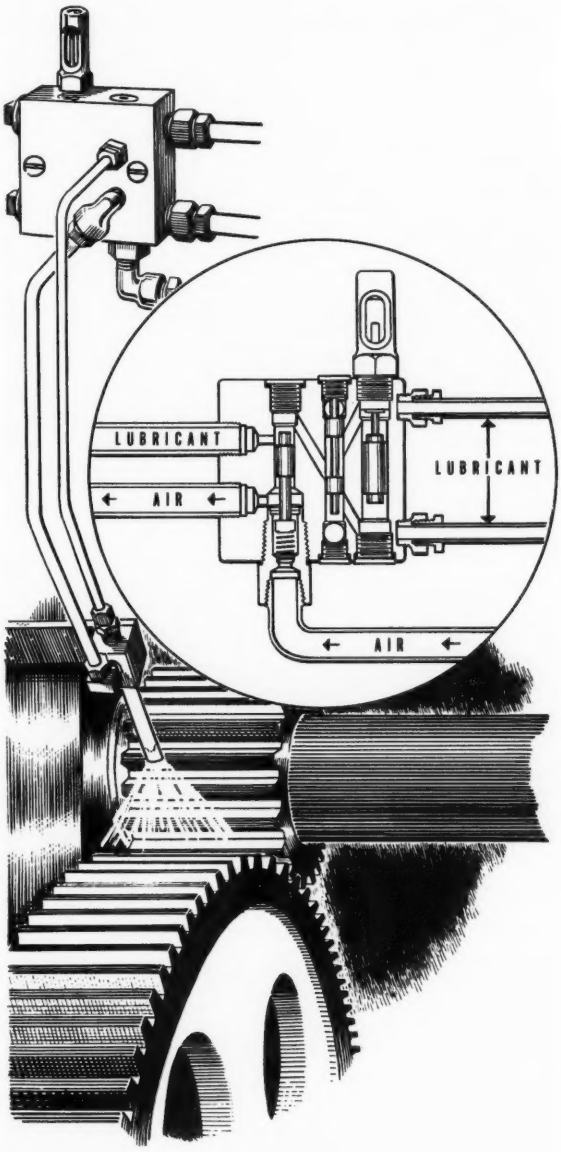

Fig. 5. Combination measuring valve and spray control valve.

on groups of grinding mills. An illustration of one of the latter installations in this same cement plant is shown in Fig. 9. This photograph shows five grinding mills whose gearing is being automatically spray-lubricated with one centralized system.

When automatic spray lubrication was first applied to gear and pinion sets on single grinding mills, the systems were designed for operation from 400 lb lubricant drums. Hardly a year had passed when it was discovered that lubricant consumption was at such a slow rate that there were hazards of the lubricant drying out and hardening in the drum. To eliminate the possibility of trouble from this source, the system design was altered to permit the use of standard 120 lb drums of lubricant. The use of 120 lb lubricant drums necessitated changing drums more frequently, thereby assuring that fresh lubricant of

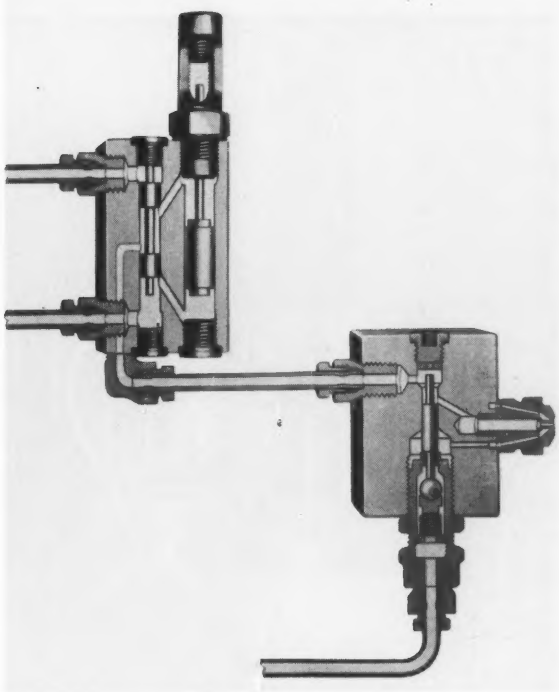

Fig. 6. Separate measuring valve and spray control valve.

uniform consistency is being applied at all times. Fig. 10 shows a complete automatic spray system for a single gear and pinion set which is operating on a 120 lb drum of gear lubricant.

During the introductory period of centralized spray lubricating systems, the lubricant suppliers were most cooperative in developing gear lubricants that could be pumped and sprayed. Their contribution to the science of spray lubrication of open gearing was largely responsible for the broad acceptance that the idea has today. Without the wide selection of open gear lubricants that can be pumped and sprayed at low temperatures without the assistance of heat, the

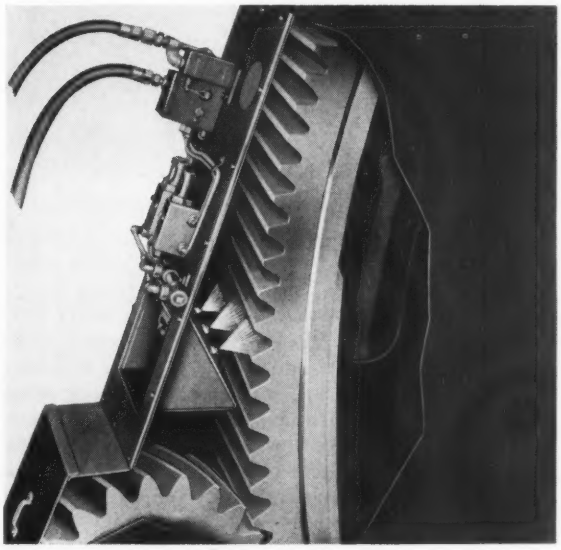

Fig. 7. Modern gear spray lubricating system.

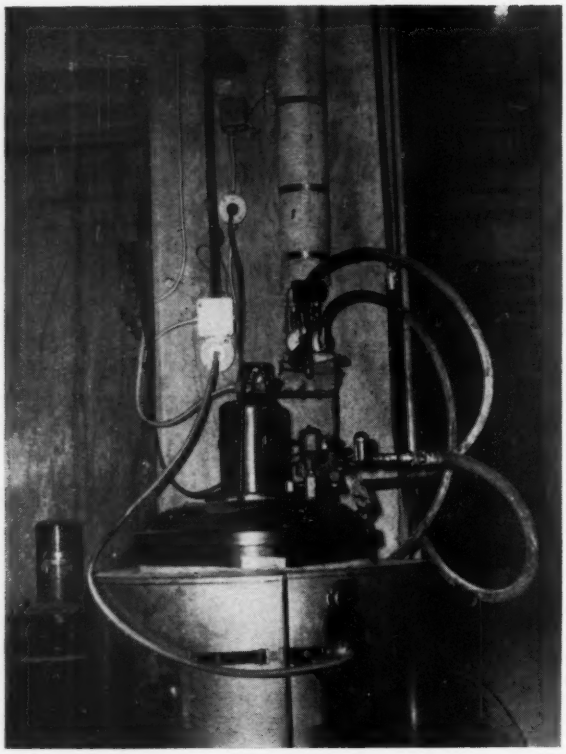

Fig. 8. Lubricant drum with drum warmer.

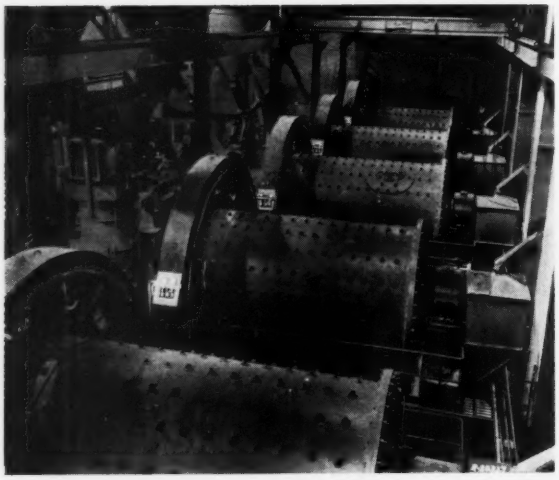

Fig. 9. Gearing of five ball mills served by one spray system.

spray lubrication idea would have run into a blind alley.

There are very few mechanical devices today that can be operated indefinitely without periodic inspection. A centralized spray lubricating system is no exception. For this reason, and because in many cases the gearing being lubricated is extremely expensive, arrangements should be made at time of installation so that the spray system can be checked at regular intervals with a minimum of effort. Fig. 11 shows how this was done on one installation. A simple hinged door was installed at right angles to the gear face in

(*Cont. on p. 409*)

Fig. 10. Spray system for single gear and pinion set.

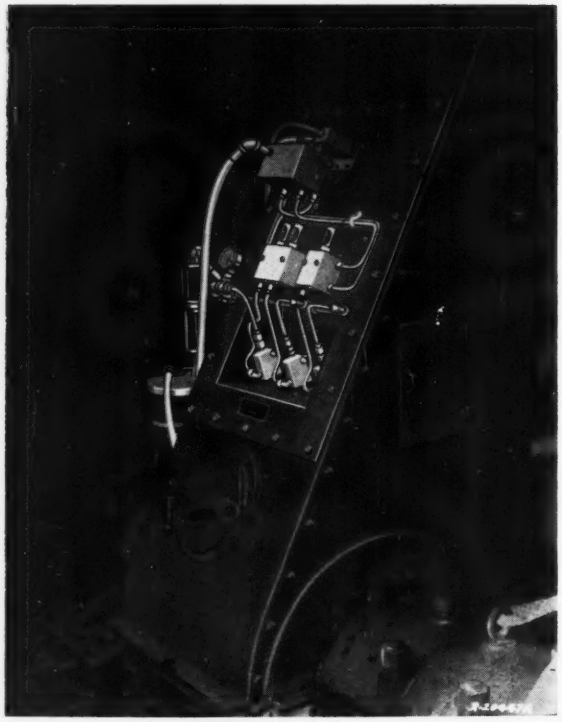

Fig. 11. Gear guard inspection door.

Development and Testing of Fire-Resistant Hydraulic Fluids For Mine Use

by S. P. Polack

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Details of a survey of the extent and conditions of use of hydraulic fluids in mining machinery and data on mine fires involving hydraulic equipment are presented in an effective argument for the use of fire-resistant hydraulic fluids. Progress of an evaluation program by the U. S. Bureau of Mines involving manufacturers and users of hydraulic equipment and field trials in normal coal mining operations is also described. The goal of the work being done is the establishment of standards for the acceptance of fire-resistant hydraulic fluids for mine use for listing by the Bureau.

Safeguarding human lives, conserving national resources, and the resultant protection of property have been foremost in all programs of the Bureau of Mines, United States Department of the Interior, since its inception in 1910. Mine fires have always been a source of concern, not only to the Bureau but to other regulatory agencies and to the industry in general. It is hardly possible to draw a parallel between a mine fire and a fire in a home or an industrial building. In the latter there is generally room to combat the fire, and the products of combustion are expended in the atmosphere. The limited headroom in a mine and the fact that the products of combustion become part of the ventilation current make fighting mine fires difficult and hazardous, if not impossible.

The gradual increase in size and capacity of hydraulically operated mine equipment has greatly increased the fire hazard. A tremendous amount of flammable hydraulic oil is taken into the face regions of mines. Mining equipment constructed to comply with the Bureau's rigid rules of permissibility is often filled with more than 50 gallons of flammable fluid and is operated in face areas where fire is always a possibility. Early in 1956 the Bureau began a program to encourage and inspire development of a reasonably priced, fire-resistant hydraulic fluid meeting operating requirements.

Mining machinery is designed to operate in a limited area that may be rather high (over seven feet), medium high, or extremely low. In any case, the machine is designed to fit into the area, and overhead room is usually limited. The width of the area of operation varies with the system of mining, the condition of overhead strata, and the type of support used. Overhead clearance frequently is measured in inches rather than feet.

The work of mining coal is in itself arduous, the coal varies in hardness and is often studded with impurities, and the bottom over which the machine has to travel can be rough and changeable in grade. Difficulty in travel causes many severe bumps and stresses. Often a machine is one of many operational units, and there may be frequent contacts between such machines. These loosen bolts and joints in equipment and cause distortions or may result in tightening that causes increased friction and in turn brings about greater internal heating. The difficulties of maintenance should be considered, as it is not feasible to remove the machine from its working position (often five or more miles from the surface or underground repair shop) for repair or adjustment. Repairs generally are made in the restricted area where the machine operates, usually under adverse conditions. In addi-

Presented before the 14th Annual Meeting of the American Society of Lubrication Engineers, April, 1959, at Buffalo, New York.

TABLE 1. Recapitulation—Hydraulic Fluid Survey (actual from reports)

Bureau of Mines office	Number of mines surveyed	Number of employees	Hydraulic fluid used (gallons)*	Coal produced (tons)	Coal produced per gallon (tons)
Pittsburgh, Pa.	71	21,317	1,544,480	24,233,091	15.69
St. Clairsville, Ohio	32	5,106	23,589	866,725	36.74
Birmingham, Ala.	19	5,825	110,217	4,296,400	38.98
Johnstown, Pa.	31	7,487	101,447	3,128,769	30.84
Norton, Va.	91	11,543	77,510	2,496,451	32.21
Barbourville, Ky.	39	5,150	74,039	3,103,219	41.91
Seattle, Wash.	5	341	1,140	47,452	41.62
Vincennes, Ind.	49	12,020	150,159	7,596,197	50.59
Morgantown, W. Va.	68	9,781	161,345	4,098,997	25.41
Mount Hope, W. Va.	201	36,594	947,814	29,964,879	31.61
Denver, Colo.	63	4,642	300,662	7,716,212	25.66
Jellico, Tenn.	9	951	3,155	547,125	173.42
Grand total	678	120,757	3,495,557	88,095,517	25.20

*The above quantities were obtained on a weekly, monthly, or yearly basis, whichever was easiest for the mine operator to furnish. The quantity of fluid is that required in producing the corresponding tonnages.

TABLE 2. Hydraulic Fluid Survey (equipment using hydraulic fluid)

Bureau of Mines office	Number of mines surveyed	Number of employees	Cutting machines	Loading machines	Drills, roof bolters, timbering machines	Shuttle cars	Continuous miners	Hoists, car spotters, compressors, etc.	Total units
Pittsburgh, Pa.	71	21,317	546	685	248	530	124	93	2,226
St. Clairsville, Ohio	32	5,106	72	151	87	129	15	6	460
Birmingham, Ala.	19	5,825	83	129	71	187	7	83	560
Johnstown, Pa.	31	7,487	115	182	59	253	61	32	702
Norton, Va.	91	11,543	134	328	111	389		7	969
Barbourville, Ky.	39	5,150	55	153	23	163		14	408
Seattle, Wash.	5	341		2			6		8
Vincennes, Ind.	49	12,020	230	300	201	521	12	37	1,301
Morgantown, W. Va.	68	9,781	207	326	260	325	25	21	1,164
Mount Hope, W. Va.	201	36,594	481	978	246	1,036	58	151	2,950
Denver, Colo.	63	4,642	127	200	108	209	9	23	676
Jellico, Tenn.	9	951	12	21	1	11			45
Total	678	120,757	2,062	3,455	1,415	3,753	317	467	11,469
Hydraulic system capacity, range in gallons			20 to 90	7 to 50	15 to 100	5 to 30	33 to 180	10 to 40	

tion, the operator of the machine and the mechanic who is repairing or adjusting it work in poor light—generally that of the cap lamps they wear.

Leakage reduces the quantity of fluid in the hydraulic system of the machine, causing extra heating as the level in the tank drops and the heat-exchange factor is reduced. It also contributes to the unsightly condition in which mining machines are often found—generally with an "overcoat" of loose coal, coal dust, grease, and oil. Because in many instances coal mining is a marginal operation, frequently the machines do not get adequate care, maintenance, and overhauling. Repairs are generally made under stress, when a machine is broken down and production stopped; however, a trend toward preventive maintenance seems to be alleviating this condition. Sometimes a machine may be operated by one with too little experience, especially where there is a labor shortage or absenteeism, and where a staggered lunch hour is in effect. In the design of a mining machine, space is always at a premium, and placing the hydraulic components is a problem. Therefore, tanks generally are smaller than those used in other industrial equipment.

So far it appears that a rather gloomy picture has been painted, but in spite of all the dark shadows, approximately 300,000,000 tons of coal is mined annually by hydraulically actuated equipment.

The hydraulic applications and the types of machines used are too numerous to list here. However, data showing the types of equipment and the extent of use are given in Tables 1 and 2. The pressures employed and type of equipment vary; and each manufacturer has his own opinion, which is expressed in the design and construction of mining machinery. Every type of hydraulic pump and motor in general use at one time or another finds its way into the assembly of the mining machine. However, gear pumps and piston pumps seem to be used more often than other types. The flexible hoses used vary in design, size, and composition, but all are subjected to flexing and wear far in excess of that encountered in industrial equipment. For the pressure range, three

of the large manufacturers of mining equipment state:

> "We work in the 0- to 1,500-psi range and find it adequate for most applications. Mining machines are not going to fly. The cylinders need to be rugged and heavy to withstand mine service. The 0- to 1,500-psi range seems to be right for cylinder applications, and we try to keep the working pressures low. High pressure circuits do offer increased efficiency and a wider range of working pressures for motor applications, and we now have several machines using the 0- to 2,000-psi circuits."

Another manufacturer states:

> "Approximately 85 per cent of our hydraulic pumps and motors are of the piston type and operate at pressures with the release valve set at 2,100 psi. The remainder is divided between vane pumps having a release valve set at 1,800 to 2,100 psi and gear pumps set at between 600 and 2,100 psi."

The third large manufacturer uses piston pumps and vane pumps with pressures up to 2,000 psi. The hydraulic fluid recommended by these manufacturers is generally within the range of 150 to 300 ssu (standard Saybolt universal, at 100F.

Attention is called to a Bureau of Mines survey to determine the quantity and type of hydraulic fluid used in operating coal-mining equipment. Reports submitted by 12 district and subdistrict offices of the Bureau cover 14 bituminous-coal-producing States. A total of 678 coal mines was surveyed; 619 of these employed 15 or more men, and this constitutes 46.3 per cent of the mines employing 15 or more men in the State surveyed and approximately 50 per cent of the 1,338 Title II bituminous-coal mines in the United States.

The 678 mines surveyed (Table 1) employed 120,757 men and produced 88,095,517 tons of coal during a period in which 3,495,557 gallons of hydraulic fluid was used in 11,469 units of mining equipment. many units had a capacity of more than 50 gallons of hydraulic fluid, as shown in Table 2. The survey indicates that one gallon of hydraulic fluid is used for each 25.2 tons of coal mined mechanically. A projection of the data for estimating yearly consumption, based on a 50-week operating period, indicates that the mines surveyed would use 10,325,337 gallons of hydraulic fluid and produce 291,876,420 tons of coal, or 28.27 tons per gallon. This quantity of fluid would cover more than 1,000 miles of 12-foot entry to a depth of ¼ inch.

It is therefore reasonably safe to assume that, in mining 300,000,000 tons of coal by mechanical means, more than 10,000,000 gallons of hydraulic fluid would be consumed. Since the industry hopes to double coal production within ten years, the amount of hydraulic fluid required would be increased accordingly, barring radical changes in design and maintenance of equipment. All fluids used in the mines surveyed were petroleum products and therefore flammable.

A scrutiny of the survey data and other information obtained from mine operators, equipment manufacturers, and producers of hydraulic fluid indicated that such fluids are purchased on the basis of price rather than scientific determination of quality for safe and efficient use. Reports show that while equipment is under factory guarantee the fluid recommended by the manufacturer is used. At the expiration of the guarantee period, price generally becomes the chief consideration. This is not a theoretical statement; it was arrived at after careful study of the specifications and price range of the hydraulic fluids recommended by the manufacturers of mining equipment and the information received at the mines during the survey. Since hydraulic systems are closed and manufacturers believe that the amount of additional fluid required after the system has been filled should be relatively small, it can be concluded from the survey and from statements by operators and oil distributors that leakage is a major factor in the consumption of hydraulic fluids.

In order that the problem may be understood more clearly and brought to the attention of all concerned, a study and analysis of reports of investigations of 59 mine fires involving hydraulic equipment were made. The results are presented in Tables 3, 4, 5, 6, 7, 8 and 9.

Early in 1956 the Bureau undertook to encourage the producers of hydraulic fluids to develop a fire-resistant fluid suitable for mine use at a price that would be acceptable to the coal-mining industry. It is interesting to note that a recent newspaper article,

TABLE 3. Geographical Distribution of 59 Fires Studies

STATE	NO. OF FIRES	PER CENT OF TOTAL
Pennsylvania	20	33.90
West Virginia	20	33.90
Ohio	7	11.87
Kentucky	4	6.78
Illinois	3	5.08
Alabama	2	3.39
Indiana	1	1.69
Utah	2	3.39
Total	59	100

TABLE 4. Salient Facts on 59 Fires Studied

59 fires in 54 mines.	
Number of underground employees in 54 mines	13,799
Daily production in 54 mines, tons	162,367
Hydraulic fluid capacity of equipment involved (5 to 110 gal.) in 59 fires, gal	3,046

TABLE 5. Height of Coal Seam in Cases of 59 Fires Studied

HEIGHT, FT.	NO. OF MINES	PER CENT OF TOTAL
Under 4	17	31.48
4 to 6	22	40.74
Over 6	15	27.78
Total	54	

TABLE 6. Daily Employment in Cases of 59 Fires Studied

MEN EMPLOYED	PER CENT OF TOTAL	NO. OF MINES	NO. OF FIRES	PER CENT OF TOTAL
Under 50	14.82	8	8	13.56
50-100	9.26	5	5	8.47
100-250	38.89	21	22	37.30
250-500	31.48	17	19	32.20
500-1,000	3.70	2	3	5.08
Over 1,000	1.85	1	2	3.39
	Total	54	59	

TABLE 7. Daily Production in Cases of 59 Fires Studied

DAILY PRODUCTION, TONS	PER CENT OF TOTAL	NO. OF MINES	NO. OF FIRES	PER CENT OF TOTAL
Under 500	9.26	5	5	8.47
500-1,000	16.67	9	9	15.25
1,000-2,500	29.63	16	16	27.13
2,500-5,000	31.48	17	20	33.90
5,000-10,000	9.26	5	6	10.17
Over 10,000	3.70	2	3	5.08
	Total	54	59	

TABLE 8. Ignition Sources of 59 Fires Studied

CAUSE	NO.	PER CENT OF TOTAL
Short circuit in trailing cable—causing heating and arcing	25	42.38
Short in cable between connecting box and motor	8	13.57
Trailing cable shorted by being run over	7	11.86
Short circuit due to damaged insulation	4	6.78
Heat and arcing due to short circuit on machine frame	3	5.09
Heating and arcing due to defective wiring	2	3.39
Ruptured splice in trailing cable	3	5.09
Electrical flash fire from machine junction box	2	3.39
*Friction due to vibration	1	1.69
Equipment short-circuited	1	1.69
Overheated resistance on machine	1	1.69
Cable of nearby machine short-circuited while under machine involved	1	1.69
Hose broken—hydraulic fluid sprayed on hot surface	1	1.69
Total	59	100

*Hydraulic hose vibrated in inlet sleeve and resulting friction caused heating of oil-soaked coal particles in sleeve.

TABLE 9. Hydraulic Fluid—Extent of Involvement in 59 Fires Studied

REMARKS		PER CENT OF TOTAL
Number of instances where hydraulic fluid became involved in fires	*43	72.88
Fire put out before hydraulic fluid became involved	7	11.86
Hoses scorched and partially burned—fire put out before igniting hydraulic fluid	5	8.48
Fire at a point remote from hydraulic parts of machine involved	4	6.78
IN ALL INSTANCES HYDRAULIC FLUID IN MACHINES WAS NOT FIRE RESISTANT		

*In most instances, extensive damage to machine followed.
Note: Accumulations of oil and oil-soaked particles of coal on machines ignited in several of the fires; rubber tires of machines also ignited.

datelined Pittsburgh, called attention to the fact that, in spite of wage increases and cost of material, the price of coal at the mine has not increased since early in 1957. As a matter of fact, in some instances there has been a decrease. Therefore, one can readily understand why the fire-resistant hydraulic fluids that had been developed for use by the military forces and industry in general were not acceptable to the mining industry, where the average price paid for hydraulic fluids is somewhere in the neighborhood of 30 cents a gallon. The enthusiasm with which the producers of hydraulic fluids attacked this problem is indeed commendable. The manufacturers of mining equipment and components for the hydraulic parts of such equipment also accepted their share of the responsibility for this research problem with enthusiasm, proving that safety is an integral part of our American scheme of things.

A testing program was instituted wherein the laboratories of one of the local steel companies, three of the leading manufacturers of hydraulic equipment, and three manufacturers of pumps used in the assembly of mining equipment cooperated with the Bureau in testing fluids that were being developed by the producers.

Many problems had to be overcome. Chief among those were certain standard properties that are taken for granted in the flammable petroleum products now in use; to name a few; viscosity, lubricity, stability, and corrosion resistance. However, research has a way of overcoming such obstacles when industries that foster such research are willing to assume the burden of cost. It is a source of satisfaction to report that considerable progress has been made. The Bureau's hydraulic fluid laboratory in Pittsburgh is conducting a series of tests to determine the fire resistance and work characteristics of fluids developed by suppliers who normally satisfy the needs of the coal-mining industry. The Bureau's pump test apparatus is designed with coal-mining machinery in mind and is therefore arranged so that the three types of pumps most commonly used in actuating the hydraulic features of mining machinery are also used to evaluate these products.

The temperature of the fluid during the test period has been a source of much discussion and was given considerable thought. Since the fluids submitted so far were invert emulsions containing approximately 40 to 50 per cent water, it was decided to establish a 150F test temperature. However, visits to several mines and observation and recording of operating temperatures indicated that in many instances the operating tem-

(*Cont. on p. 410*)

Silicone greases are known to be useful in a variety of applications. These particular static tests were conducted at 38C on commercial and experimental greases to show their probable limits of radiation stability since an increasing number of uses involves radiation resistance.

Silicones as a class have been termed inferior in radiation stability. These statements usually refer to silicones containing a major amount of methyl substituents and little or no phenyl substitution. Actually, within the silicone class a wide variety of fluids exist, some of which are very stable in radiation environments. This report will point out the degree of radiation stability of the fluids and the extrapolation of this characteristic to grease formulations.

Radiation Stability of Silicone Greases

by D. J. Fischer, J. F. Zack, Jr. and E. L. Warrick

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In order to visualize the scope of radiation stability of silicone greases, three significant variables were studied: the first, the inherent stability of the fluid to radiation as measured by G(gas), molecules of gas evolved per 100 e.v.; the second, the molecular weight; the third, the differential effect of filler.

Of these three variables, the G(gas) is the first variable that must be considered for development of a radiation stable grease. Low G(gas) values are indicative of radiation stability, while high values indicate radiation induced chemical breakdown. After the inherent stability of the fluid is satisfied, the molecular weight range and filler are chosen to complement this stability. Disregard of these latter two variables can completely nullify the advantage of initial stability of the fluid.

IRRADIATION FACILITIES AND EXPERIMENTAL TECHNIQUES

Grease formulations involved three roll milling various thickeners into fluids. In order to minimize variations as the result of multiple additives, a single fluid and thickener (filler) were used in each case. Each formulation was divided into two parts, one for reference measurements and the other for radiation treatment in four-ounce tin-plated steel cans. The position of the cans in relation to the Co^{60} was such that the intensity of radiation was virtually constant throughout the sample at a level of 0.4 megareps per hour. The ambient temperature of the Co^{60} source was 38C.

EXPERIMENTAL RESULTS

Evaluation of the effects of irradiation on the greases was made by measuring the micropenetrometer (Procedure D217-52T with micro cone and cup) values of the grease as it was treated with increasing amounts of irradiation. These values increase during low dose treatment and later, after reaching a critical value, decrease to the point that a rubbery material

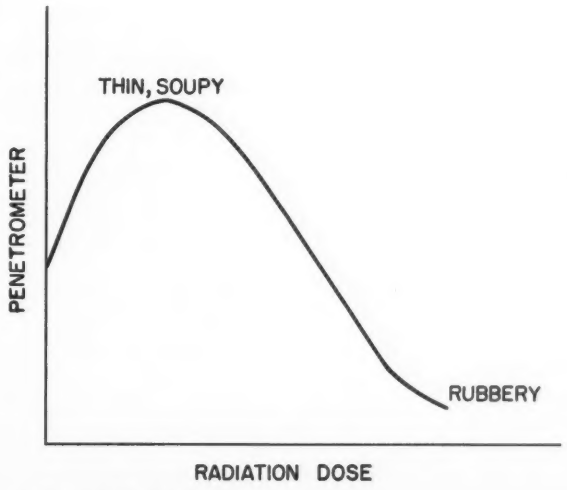

Fig. 1. Radiation induced changes in consistency.

is obtained. All greases go through variations of this cycle (Fig. 1). Many greases become so thin at the peak penetrometer measurement that they are no longer useful. It is apparent that one needs the whole series of penetrometer measurements at various dose levels to avoid a misleading appraisal based on single radiation. For this reason a complete set of penetrometer measurements as a function of radiation dose was made in these investigations.

A range of G(gas) is available with siloxane fluids. A fluid can be selected for use in a radiation field when the specified radiation dose is given. The four fluids of Table 1 give an idea of the range of G(gas) available in present commercial and experimental fluids. A ratio of 31 exists in differential radiation stability. These G values are plotted in Fig. 2, along with a point for a research fluid against the electron fraction aliphatic (1, 2). One may predict radiation stability from fluid composition using this graph. As the electron fraction aliphatic (the number of electrons associated with all the atoms of the

TABLE 1. PROPERTIES OF COMMERCIAL SILICONE FLUIDS

FLUID	ELECTRON FRACTION ALIPHATIC	G(GAS)	MOLECULAR WEIGHT	VISCOSITY CS.	COPPER PHTHALOCYANINE LOADING
$(Me_2SiO)_4$	0.450	2.60	296	2.3	—
550	0.283	0.308*	1420	125	30 weight %
QF-6620	0.245	0.157	632	38	28 weight %
710	0.189	0.082*	1250	375	27 weight %

*Reference 3.

aliphatic groups divided by the total number of electrons of the atoms in the entire molecule) decreases, a definite trend toward more radiation stability exists.

A prespecified G(gas) value can isolate the composition of the siloxane for that radiation stability use. However, a question may arise as to whether this degree of radiation stability can be extrapolated to relative grease stability. In order to answer this question, three fluids, 550, QF-6620 and 710 were thickened with copper phthalocyanine (Thickener A) at equivalent loadings and treated with radiation in a similar manner. The micropenetrometer measurements on these three greases were taken at various increments of radiation dose. The results are plotted in Fig. 3. The higher G(gas) value 550 fluid goes through its complete cycle below a total dose of 850 megareps, while the lower G(gas) 710 fluid's micropenetrometer changes very little throughout a range of 1300 megareps. The G(gas) value of QF-6620 is between that of 550 and 710 and it shows an intermediate behavior. Actually, QF-6620 is showing better radiation resistance than its G(gas) value alone would indicate as the result of its low molecular weight. The molecular weight of QF-6620 is approximately ½ the 550 and 710 fluids.

This behavior shows that G(gas) values can aid in selection of fluids for radiation resistant grease formulations. It also points out that a low molecular weight base fluid can aid in the development of a radiation resistant grease formulation.

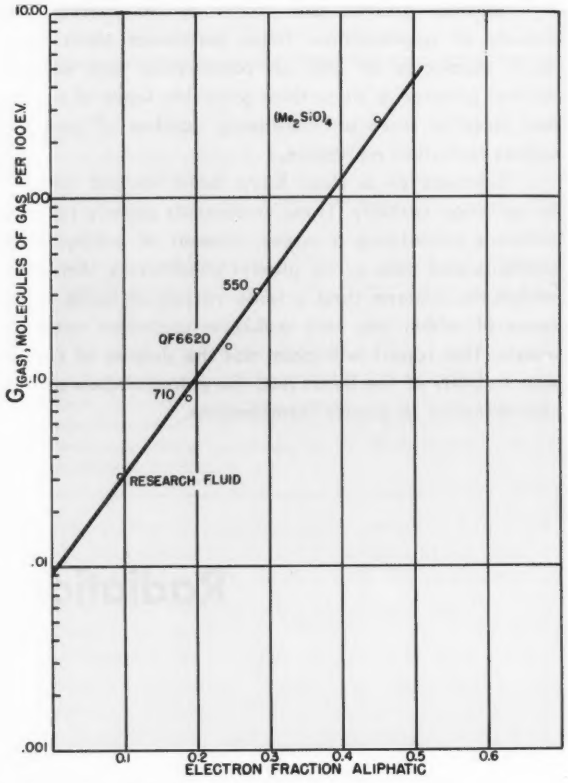

Fig. 2. Radiation stability as a function of composition.

The second variable of molecular weight or viscosity of the fluid has been discussed in conjunction with the preceding examples. Its isolated significance can be pointed out by these two extreme examples. A high molecular weight dimethylpolysiloxane, 10^6 centistokes fluid, will gel before a radiation dose of 5.0 megareps, while a low molecular weight, 1.0 centistoke fluid, will gel after 1500 megareps.

The third variable of filler is quite significant and points out the futility of comparing one fluid in a grease formulation with another unless the fillers are the same. A series of fillers was used to thicken 710 fluids. Each one of these greases was then treated with radiation in a similar manner. The data obtained with these systems are summarized in Fig. 4. Here we can see that carbon black (Thickener B) is a poor thick-

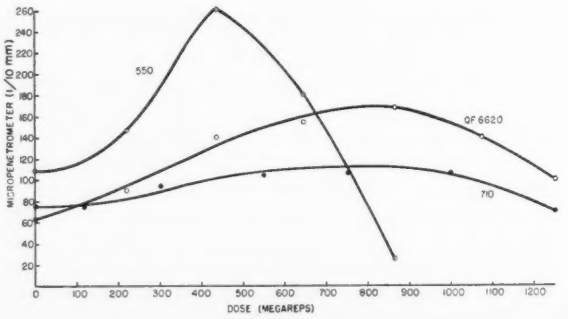

Fig. 3. Silicone fluids in copper phthalocyanine greases.

ener for siloxane fluids in that it causes them to become thin or too soupy at relatively low radiation dose. Copper phthalocyanine is an excellent thickener in that very little change in penetrometer is observed throughout a range of 1300 megareps. The other fillers have intermediate effects.

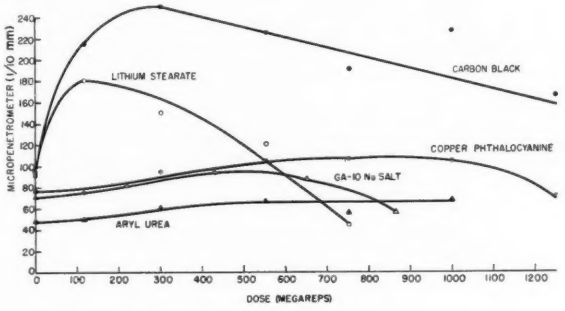

Fig. 4. Filler effect in radiation resistance of 710 greases.

The last point on each of these curves was taken while the mixture was still homogeneous. An additional dose of 200 megareps gave a rubbery material for the copper phthalocyanine, lithium stearate (Thickener C), GA-10 sodium salt (Thickener D) fillers and a very lumpy liquid for the carbon black and the aryl urea (Thickener E) fillers.

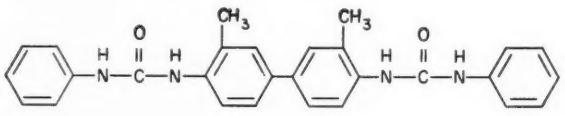

Fig. 5. Substituted aryl urea.

Since copper phthalocyanine, of the thickeners tested, seemed to be the best for siloxanes used in radiation environments, duplicate formulations and dose treatments with the 550 and 710 fluids were conducted. The results were equivalent to those already presented in this article.

CONCLUSIONS

Within the class of silicone materials, a group of radiation stable fluids exists. The stability of these fluids can be translated to grease formulations if the proper fluid molecular weight and filler type are used.

Siloxane fluids with higher aromatic content are more radiation stable as shown on the G(gas) versus electron fraction aliphatic (range 0.09) plot. Greases prepared with these fluids and suitable fillers can be expected to be superior high temperature radiation stable materials.

710 fluid filled with copper phthalocyanine has very little change in consistency throughout a 1300 megarep static test irradiation treatment. This stability justifies the dynamic test measurements which are in progress.

ACKNOWLEDGMENT

The authors wish to express their thanks to William H. Ragborg and William H. Badger of the Lubricants and Release Products Laboratory, Dow Corning Corporation, for their formulation of the greases and their subsequent micropenetrometer measurements.

LIST OF THICKENERS OR FILLERS

A. Copper Phthalocyanine, Special Grade, D31-28896.
B. Carbon Black, Battery Black M7172.
C. Lithium Stearate (Neutral Grade).
D. GA-10 Sodium Salt.
E. Aryl Urea, Fig. 5.

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MODERN TECHNIQUES FOR SPRAY LUBRICATING INDUSTRIAL GEARING

(Cont. from p. 402)

the vicinity of the spray nozzles so that a cardboard could be inserted to check the spray pattern.

In 1956, a spray system data sheet, based on actual field practice, was established. This sheet covered the type of lubricant used, quantity of lubricant sprayed per system cycle, system time cycle, and gear dimensions for 12 different installations. In studying over the data sheet and comparing it with the proposed tentative AGMA standard specification for lubrication of industrial gearing, it was interesting to find that the practice in the field with respect to quantity of lubricant applied varied from 80 per cent below to 566 per cent above the AGMA recommended quantity. This illustrates that the practice in the field varies widely and it is therefore necessary to design the greatest possible flexibility into a spray lubricating system to enable it to handle a broad range of conditions.

Some important work has been done recently by an outstanding lubrication engineer in one of the New York State steel plants in connection with lubricating gearing and associated plain bearings with one lubricant and one lubricating system. The system covers 65 points of lubrication on a mill table. Thirty-eight of the points serve table roll and line shaft bearings and the remaining 27 points spray lubricant onto open gearing. A lithium soap base grease is used on this application, and the frequency of the system cycling is once per hour. Before installing the system, 40 lbs of gear lubricant and two gallons of bearing lubricating oil were consumed in an eight-hour operating turn. The new lubricating system is doing a more effective lubricating job with but 1.6 lbs of lubricant per eight-hour operating turn—savings of 38.4 lbs of gear lubricant and two gallons of oil per shift. A little simple arithmetic will show that the system paid for itself in

a short time on lubricant savings alone. However, that is not all of the story. Bearing life was increased 40 per cent, and it is estimated that gear life increased approximately 75 per cent. With fewer bearing and gear replacements it is only natural that there would be less down-time on the mill.

The science of spray lubrication has made considerable progress since the idea was originally conceived some 18 years ago. It appears that even greater progress is in view for this type of equipment in the years to come, as the surface has been barely scratched in this broad field of application.

DEVELOPMENT AND TESTING OF FIRE-RESISTANT HYDRAULIC FLUID FOR MINE USE

(Cont. from p. 406)

perature exceeds 150F. Incidentally, this is the temperature that manufacturers of mining equipment stipulate should not be exceeded, and it was decided that the temperature of tests should go a lot higher than 150F. Therefore, the Bureau's tests are conducted as follows:

A 1,000-hour test at 1,000 psi was divided into two parts—the first 500 hours at 150F and the final 500 hours at 190 F. The pump is removed from the test stand, disassembled, and evaluated after each of the two phases of the test. In the first test a gear pump was used. This pump was evaluated by the hydraulic engineers of the manufacturer of the pump and one of the larger manufacturers of mining equipment. It was determined that the wear was negligible. It was the consensus that the pump could have been used far longer than the test period. At that time an arrangement was made whereby the tests conducted by the Bureau would be paralleled by tests conducted by a local steel company, and it was decided that the pump parts should be weighed for comparison. Therefore, when the next test, using a piston pump, was started the critical parts of the pump were weighed. They amounted to 4,306.6118 grams. During the first stage, at 150F, the weight loss was but 0.5066 gram. During the second stage, at 190F, the weight loss was 1.8413 grams. Thus, the total weight loss during the 1,000 hours was 2.3479 grams, denoting a weight loss of 0.054 per cent. At this writing a third test is well underway, using a vane pump. This test will, in essence, follow the two preceding tests.

Laboratory testing, although desirable, is not in itself sufficient. Therefore, field trials were arranged at mines where the fire-resistant hydraulic fluid was used to actuate mining machinery engaged in normal operations of producing coal. The operators of these machines are not laboratory technicians; and the results of these tests, some of which have been carried on for a considerable time, indicate that fire-resistant hydraulic fluids can be used successfully to actuate mining machinery and can be produced at a price that will be acceptable to the safety-conscious mining industry.

The high operating temperatures previously mentioned were not encountered in two of the tests. In one instance where the hydraulic-fluid tank on a shuttle car had only 4-½ gallons capacity a 15-gallon auxiliary tank was installed. This resulted in an amazing reduction in operating temperature. A heat exchanger was installed on a cutting machine under test and brought about an equally large reduction in operating temperature.

Work is underway at present to establish a schedule of acceptance wherein the Bureau will test for fire resistance those fluids that have, in the laboratory and in field tests, given a degree of evidence that they will operate efficiently in coal-mining machinery. Fluids successfully passing the tests will be accepted for listing as fire resistant by the Bureau.

In conclusion, the Bureau wishes to commend all who have participated in this research project. The producers of hydraulic fluids, who have graciously and gallantly borne much of the cost of this project and assigned capable and dedicated people to do the work; the manufacturers of mining equipment and components, who have shown willingness to surround their products with all the safeguards conceivable to make mining a safer industry; and the mine operators, who are willingly cooperating by furnishing their equipment for mine tests, knowing that if unsuccessful they will be burdened with the cost of replacement of equip- and loss of production, and if successful they may have to pay more for their hydraulic fluid. The mine workers who operate this equipment should be commended for their eagerness in following instructions and doing their part to make fire-resistant hydraulic fluids for mine use an actuality rather than a dream. It can be noted in closing that fate regulates the lives of men in many ways. The first field trial of a fire-resistant hydraulic fluid was held at Monongah, W. Va., the scene in 1907 of the worst mine disaster in the history of the United States.

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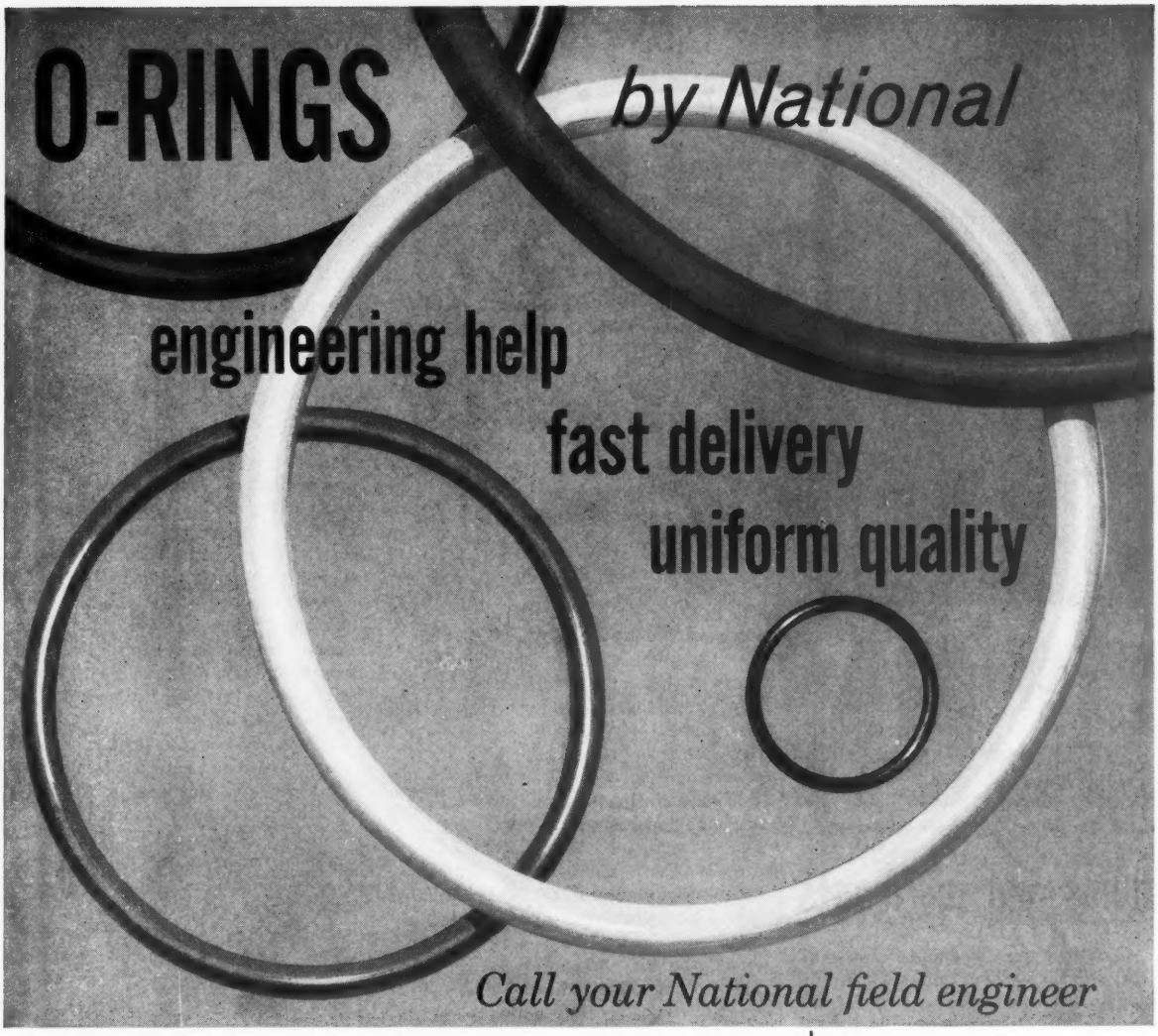

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Patent Abstracts

Compiled by Ann Burchick

Aluminum Co. of America

Lubricating Grease Compositions Containing N-Acyl-p-Amino Phenols, Patent #2,824,838 (D. W. Young and D. L. Cottle, assignors to Esso Research & Engineering Co.) A lubricating grease composition consisting essentially of a lubricating oil thickened to a grease consistency with a grease making metal soap of a fatty acid having combined therein a minor, but oxidation resistance improving amount, of a compound.

Lubricants, Patent #2,824,839 (G. C. Templeman, assignor to The Ohio Oil Company) A mineral oil lubricant composition comprising (a) a major proportion of a mineral oil lubricant selected from the class consisting of mineral oils and greases, and (b) as the film strength enhancing constituent of said composition a small amount, sufficient to enhance the film strength of the lubricant, of a di(halo-alkyl), mono-olefinic aliphatic hydrocarbon-radical-substituted phosphonate additive wherein the mono-olefinic hydrocarbon radical is linked by a carbon directly to the phosphorus and each of the two halo-alkyl radicals is linked respectively to a separate one of the oxygens linked to the phosphorus, which additive is soluble in the lubricant ingredient at least in said small amount and, in such small concentration in the lubricant, is inert to water, stable at elevated temperatures, and non-corrosive to the ferrous and non-ferrous metals and their alloys that are used in devices requiring lubricants; said composition having enhanced film strength over that which the mineral-type lubricant itself has without this additive.

Lubricating Oil Composition, Patent #2,824,840 (E. P. Cashman and Ethel J. Corcoran, assignors to Esso Research & Engineering Co.) A lubricating oil composition comprising a major proportion of a lubricating oil and a minor pour depressing amount of an oil-soluble polymeric material having a molecular weight of at least about 1000 selected from the group consisting of (1) polymers of a complex ester, (2) copolymers of said complex ester with a diester and (3) copolymers of said complex ester with vinyl acetate, said complex ester being prepared by esterifying two moles of an alpha, beta unsaturated dicarboxylic acid having four to seven carbon atoms per molecule with one mole of a glycol.

Non-Foaming Grease-Making Process, Patent #2,825,692 (A. J. Morway, assignor to Esso Research & Engineering Co.) In a process for preparing soap base greases wherein the soap is formed by saponifying fatty oils with soap-forming metallic hydroxides in the presence of lubricating oil and wherein the saponification is carried out at a final temperature of at least 500F and sufficient to cause substantial foaming, the improvement which comprises limiting the amount of lubricating oil admixed with the saponifying material during the saponification to form a soap-oil concentrate containing from 45 to 65 per cent soap, cooling the hot saponified product to a solidifying temperature while maintaining said product in a quiescent state, and thereafter oiling back the soap-oil concentrate to produce a finished grease of desired soap concentration.

Metal Working Lubricant, Patent #2,825,693 (S. J. Beaubien, T. E. Reamer, and P. H. Williams, assignors to Shell Development Co.) A metal working lubricating concentrate comprising a water base composition containing from about 5 per cent to about 20 per cent each of (1) a block copolymer of polyoxypropylene polyoxyethylene compounds containing in their structure hydrophobic oxypropylene groups, hydrophilic oxyethylene groups and an organic radical derived from an organic compound containing a reactive hydrogen atom; the compounds being characterized in that all of the oxypropylene groups are present in polyoxypropylene chains that are attached to the organic radical at the site of a reactive hydrogen atom thereby constituting a hydrophobic polyoxypropylene polymer, the oxyethylene groups being attached to the polyoxypropylene polymer in polyoxyethylene chains, the molecular weight of the hydrophobic polyoxypropylene polymers in the mixture being at least 900, as determined by

(*Cont. on p. 416*)

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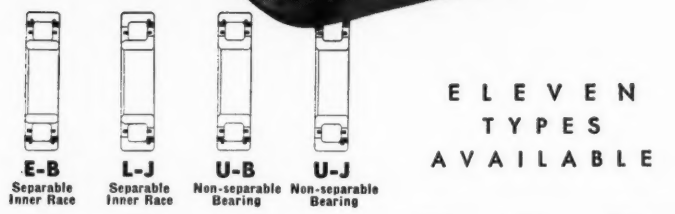

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"Coolant Microbiology: The Role of Industrial Research," E. D. Kitzke, R. J. McGray, S. C. Johnson and Son, Inc., Racine, Wisconsin.

The field of industrial microbiology is to a great extent an unexplored wilderness. However, recent work at the academic level and an awakening interest at the industrial level indicates that progress in solving microbiology problems may soon be made.

At first sight it appears that spoilage of emulsion coolants is a very erratic problem. However, when viewed on a national scale it seems quite reasonable to make the statement that eventually every machine shop, regardless of the coolant being used, will encounter some form of microbial contamination detrimental to the coolant. This is primarily the result of ignorance upon the part of both the coolant manufacturer and the industrial user on how to prevent microbial spoilage over long periods of use. Secondly it is due to an unwillingness on the part of the manufacturer and user to recognize that certain limitations do exist, and therefore practices in the field use of coolants should be governed accordingly. Industrial users can play a part in minimizing these problems, but the coolant manufacturer probably will have to make specific recommendations and assume the educator's role.

Laboratory and field evaluations have been conducted by the authors on coolant formulations requiring cidal additives (additives having the potential to kill bacteria) as protectants. Although in the present discussion emphasis is placed on coolants having such additives, formulations which have such a low susceptibility to microbial attack that cidal additives are not necessary have also been studied.

Potential cidal candidates for use in coolants are subjected to a primary screening in which the following qualities are evaluated:

1. Economic levels of use
2. Chemical compatability with formulation concentrate
3. Effective cidal quality
4. Stability in storage
5. Absence of malodor or discoloration effects of the concentrate or diluted product
6. Non-hazardous to the machine operator because of inhalation toxicity, dermal toxicity, or allergenic properties.

Candidates passing the preliminary screening are then evaluated by bacterialogical techniques. The experimental product is tested in comparison to unprotected control samples and certain other standard formulations of known effectiveness. An important test consists of innoculating the test sample with species of microbes from spoiled coolants that have a known ability to degrade such products. Bacterial counts are made at selected intervals. The decrease in the bacterial population, or increase in the case of a failure, can be plotted against time and compared with various standards. Products that show the necessary ability to destroy the inoculm within a prescribed time are then subjected to a third screening.

The third phase utilizes a simulated machine shop sump setup, complete with metal chips, to determine the possible effect of any chemical reaction between the coolant and metal chips on microbial populations. If necessary, deliberate innoculations with selected bacteria or molds can be made to provide severe contamination conditions. This phase of testing may run for as short a period as two weeks or as long as two months with daily samplings being made.

Formulations which survive the first three phases of testing must face the final test of use under actual conditions in machine shops located near enough to the laboratory to permit rapid processing of samples.

A number of closely controlled field trials and experiences have indicated that a well formulated coolant, when not abused, can function perfectly in machine environments that were formerly considered to be chronically rancid.

From laboratory and field data it is possible to predict maximum coolant life for specific formulations under typically severe operating conditions, and also to recommend coolant change schedules.

It would seem then, that the role of industrial research should be one of providing coolant products which could be marketed with fore-knowledge as to probable susceptibility to microbiological breakdown. The optimum conditions for trouble-free use, and recommendations on how to overcome a microbial contaminant when it does play havoc with production line operations should also be determined by research. The manufacturer of coolants should take the lead in enlarging knowledge on this subject and disseminating it to industry. (*Digested by H. J. Connors*)

"Low Shear Rate Grease Mobility," E. L. Armstrong, Socony Mobil Oil Co., Brooklyn, New York and J. Simon, National Tube Division, U. S. Steel, McKeesport, Pa.

Despite the great strides that have been made in recent years in both grease formulation and in the design of grease lubrication systems, some dispensing problems still exist. Although many investigators have contributed to the understanding of the flow properties of greases in lubricating systems, in most of the investigations pipe diameters greater than ½ inch were not considered and the shear rates covered generally were greater than ten reciprocal seconds. However, many industrial plants employ long runs of two inch diameter pipe in their grease dispensing systems, which give rise to shear rates that are much lower, sometimes in the order of 0.05 reciprocal seconds. The authors feel that the subject of pressure drops in long lines at such low shear rates should receive more attention.

Tests to determine grease flow rate and pressure drop relationships were carried out on a long, dual line lubricating system in a steel tube plant. The particular system was selected because the header lines were exposed and accessible for instrumentation.

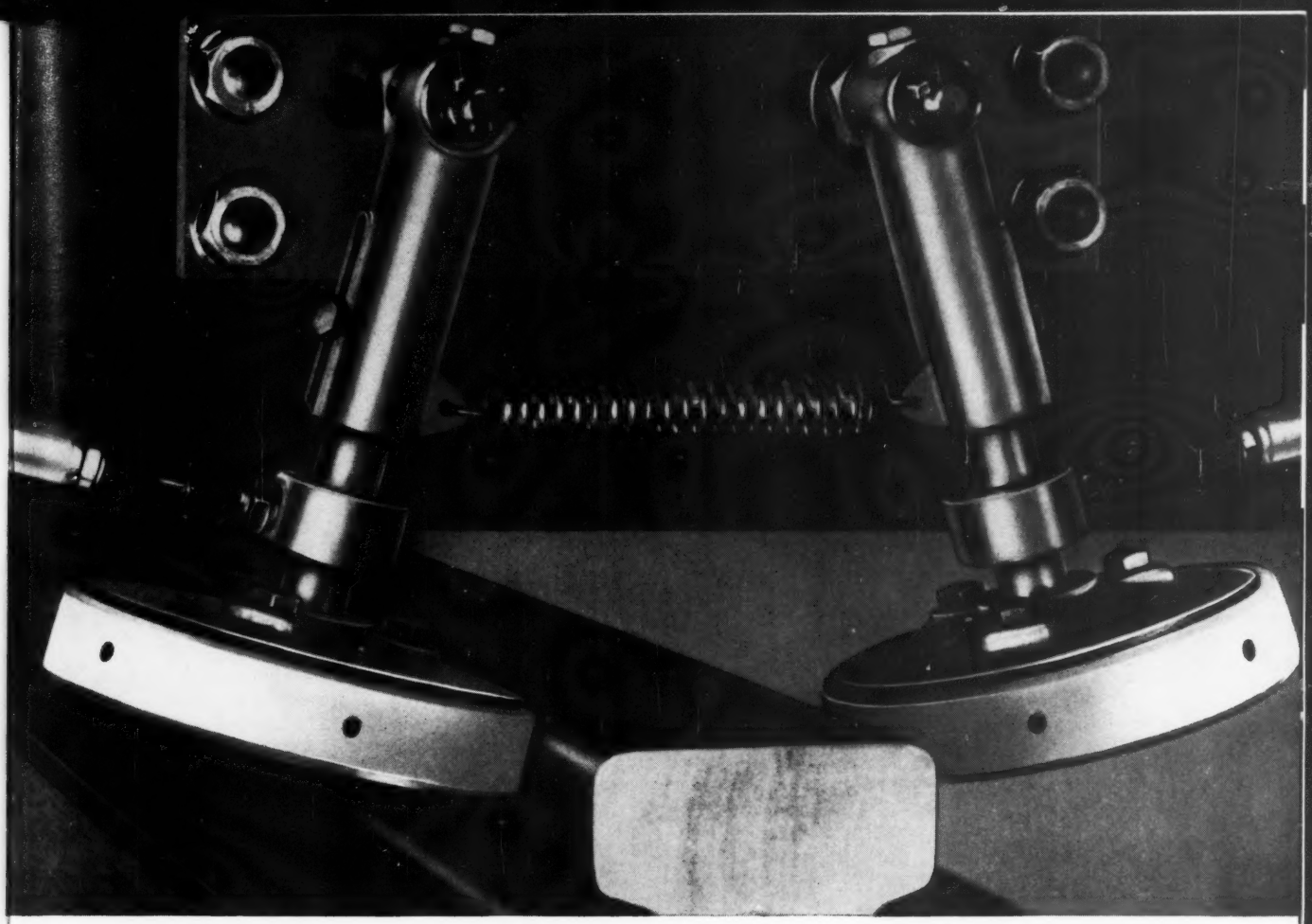
The system was composed of sections of ⅜, 1, 1-½, and 2 inch diameter piping in lengths of 20, 80, 150, and 300 feet respectively. Tests were run at three flow rates corresponding to the normal flow rate required for plant lubrication, a flow rate less than normal, and a flow rate greater than normal. At the normal flow rate the shear rate was found to vary from 0.17 reciprocal seconds in the two inch pipe to 44.8 reciprocal seconds in the ⅜ inch pipe. An analysis of the pressure drop data showed that for all three flow rates the pressure drop in the section of two inch diameter pipe accounted for approximately 1/3 of the total pressure drop in the system.

The conclusions reached from the study indicate that test criteria at very low shear rates are necessary to properly evaluate grease flow in long line grease dispensing systems. (*Digested by H. J. Connors*)

"Power Lubrication as Applied to Farm Implements," by W. H. Schurk.

The trend towards perfection of automatic lubrication devices has led to the

(*Cont. on p. 420*)



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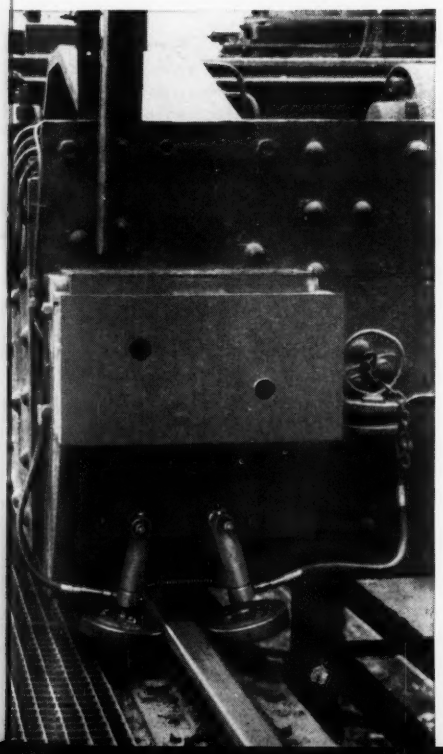

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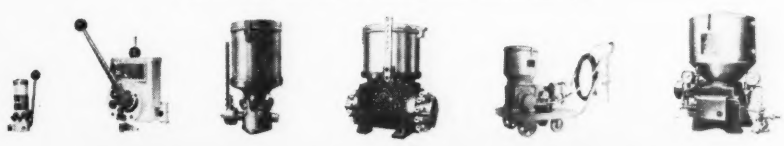

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PATENT ABSTRACTS

(*Cont. from p. 412*)

hydroxyl number, and the oxyethylene groups present constituting 15-90 per cent by weight, of total block copylymers, and (2) a mixture of heteric oxyethylene-oxy 1,2-propylene diols in which ethylene oxide and 1,2-propylene oxide are combined therein as oxyethylene and oxy 1,2-propylene groups in a ratio which is at least one-third part of 1,2-propylene oxide for each part of ethylene oxide, by weight, said diols containing in a single molecule both the oxyethylene and the oxy 1,2-propylene groups and said mixture having an average molecular weight of at least 300 attributable to said groups, from about 1 per cent to 12 per cent each of (3) sodium nitrite and an ethanolamine and from about 0.01 per cent to about 5 per cent of (4) an unsaturated high molecular weight fatty acid.

Process for the Preparation of High Temperature Anti-Friction Bearing Lubricants, Patent #2,825,694 (A. J. Morway, assignor to Esso Research & Engineering Co.) The method of preparation of channeling type high temperature anti-friction bearing grease lubricating composition which comprises heating a mixture of mineral oil, a small amount of an oil-soluble sodium sulfonate and sufficient rapeseed oil to give a final product containing 20 per cent to 30 per cent soap, adding aqueous sodium hydroxide in a slight excess over that necessary to completely saponify the rapeseed oil, further heating the rapeseed oil to dehydrate the mixture, adding additional mineral oil and continuing the heating to about 480F to 520F with stirring, cooling the resulting composition to a temperature below about 275F, adding an additional amount of mineral oil sufficient to result in a grease composition containing about 10 per cent to about 15 per cent soap and subjecting the mixture to the action of shearing forces under streamlined conditions to obtain a smooth unctuous grease composition having an ASTM worked penetration of at least 275 mm./10.

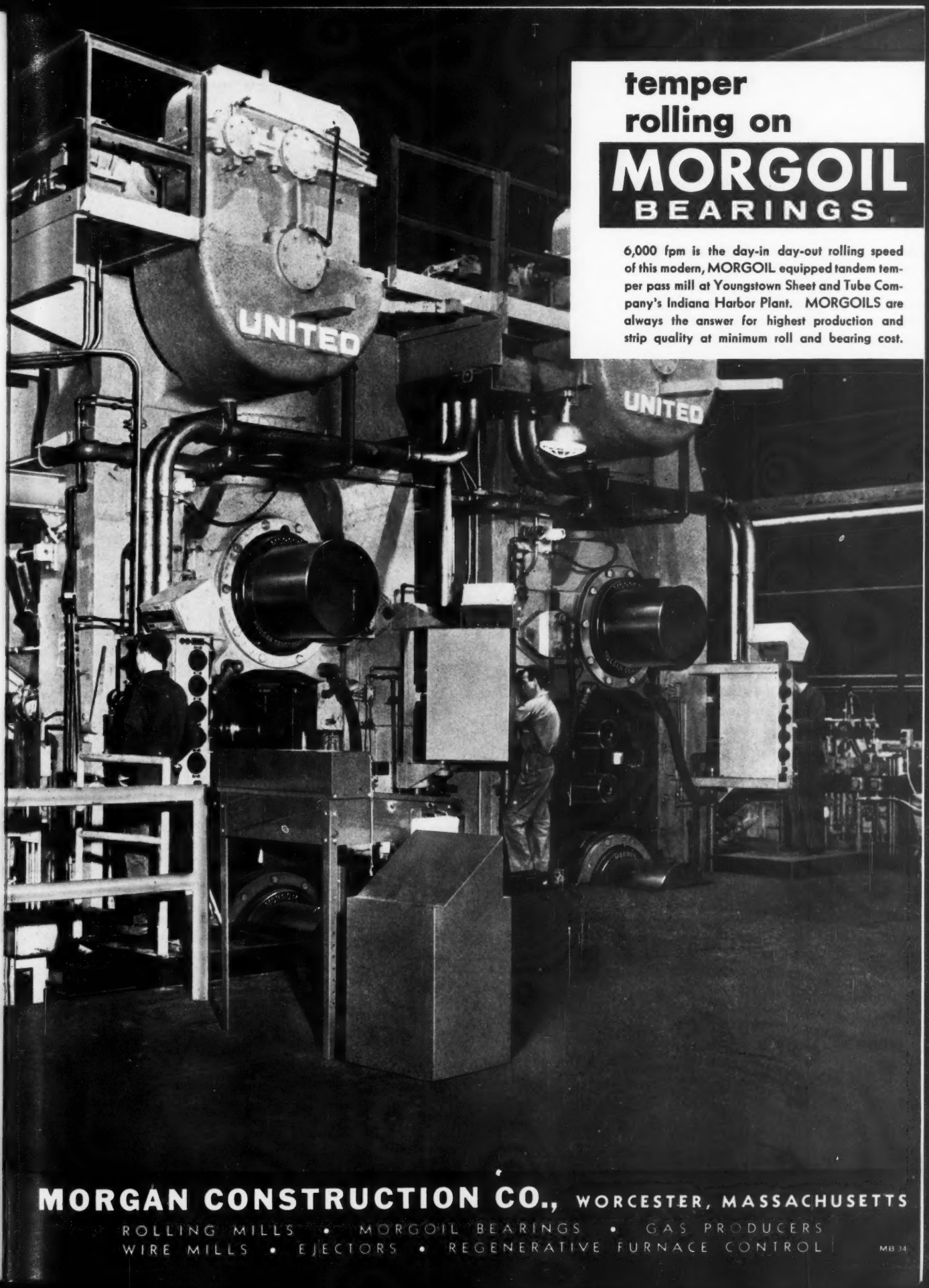
Lubricating Compositions, Patent #2,825,695 (C. L. Mahoney and H. Diamond, assignors to Shell Development Co.) A mineral lubricating oil comprising a major amount of an aromatic-free essentially isoparaffinic lubricating oil obtained by isomerizing a paraffin wax in the presence of hydrogen and an isomerizing catalyst at a temperature between about 300C and 550C and thereafter dearomatizing the oil and having incorporated therein from about 0.05 per cent to about 5 per cent of an oil-soluble cadmium dithiocarbamate and from about 0.05 per cent to about 2 per cent of an oil-soluble halogen-containing phosphorus organic compound.

Naphthenates as Soluble Oil Emulsifiers, Patent #2,826,549 (A. A. Manteuffel and G. R. Cook, assignors to The Pure Oil Co.) An emulsion-stable soluble oil composed of 87-95 per cent by weight of petroleum lubricating oil aromatic solvent extract of approximately 3-4 acid number, diethylene glycol as a coupling agent in the amount of about 2.25-2.9 per cent by weight, 4-7.7 per cent by weight of an emulsifier-forming agent consisting substantially only of anphthenic acids having a molecular weight of 280-500 and an acid number of 157-159, about 0.8-1.25 per cent by weight of potassium hydroxide, and about 0.9-1.2 per cent by weight of water, said soluble oil having an acid number of about 1.4 to 3.2.

Extreme Pressure Lubricant Composition, Patent #2,827,433 (F. B. Fischl and W. E. Waddey and F. J. Beyerstedt, assignors to Esso Research & Engineering Co.) An improved extreme pressure lubricating oil which comprises: a mineral oil having an SUS viscosity at 210F in the range of 50 to 150; 8 to 12 wt per cent of a dipentene-treated reaction product of a mineral lubricating oil and P_2S_5, formed at a temperature in the range of 200 to 600F, and 0.5 to 2 wt per cent of chlorodibenzyldisulfide, the weight ratio of said dipentene-treated reaction product to said disulfide being in the range of 5:1 to 20:1.

Corrosion Preventing Agent, Patent #2,826,550 (J. P. McDermott, assignor to Esso Research & Engineering Co.) A mineral oil containing dissolved therein a corrosion inhibiting amount of an oil-soluble compound.

Waterproof Silica-Base Greases, Patent #2,891,010 (T. W. Martinek, assignor to The Pure Oil Co.) A silica-thickened grease having enhanced water washout characteristics consisting essentially of a lubricating oil having incorporated therein a finely divided silica gelling agent in an amount sufficient to impart a grease-like consistency to said lubricating oil, and a composite water-proofing agent consisting essentially of four-ten parts by weight of (1) an oil-soluble mono-alkyl ether of a polyoxyalkylene glycol produced by reaction of a monohydric aliphatic alcohol and 1,2-propylene oxide having a molecular weight of 800-1600 (acetyl value), and one part by weight of (2) an oil-soluble mono-alkylaryl ether of a polyoxyethylene glycol produced by reaction of a C_1-C_{18} alkyl-substituted phenol and ethylene oxide having an average molecular weight of 200-550, said waterproofing agent being present to the extent of nine-ten per cent by weight of the silica in an amount sufficient to improve substantially the water-washout characteristics of said grease.



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Twin Cities	L. M. Fleming	R. C. Johnson, 3720 Adair Ave. North, Minneapolis 22, Minn.	Last Thursday—Dyckman Hotel, Minneapolis, Minn.
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2. SPECIAL EXTREME PRESSURE EXCEEDS MINIMUM 45 POUND TIMKEN O. K. LOAD RATING
3. RESISTANT TO WATER
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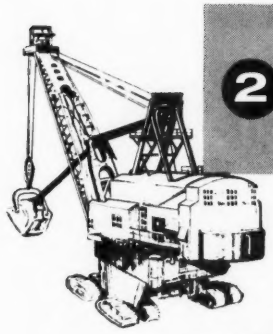

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Timken O. K. Load, Minimum	45 lbs.
Pressure Bleed Test, Per Cent Maximum	5.0
Shear Stability	Excellent
Water Resistance	Excellent
Norma Hoffmann Oxidation Stability, 100 hrs. @ 210° F.	5 lb. Max. Drop
Wheel Bearing Test	Pass
Rust Protection	Pass
Texture	Buttery
Color	Amber
Drop Point, °F.	None
Mineral Oil Specifications:	
Viscosity @ 210° F.	60-70
Viscosity @ 100° F.	450-650
Flash, °F., Minimum	425
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ASLE TECHNICAL DIGEST

(*Cont. from p. 414*)

development of some unique mechanisms;—diverse in design but all involving a common objective: low cost lubrication by measured, pressure delivery of lubricant from a centralized system.

In discussing the centralized power lubrication systems made by the author's company for use on farm implements, mobile vehicles and industrial machinery, the author indicates that the basic characteristics of the systems include:

1. Measurement or metering of lubricant at the source.
2. Positive displacement to assure of uniform delivery.
3. Adequate pressure to offset line resistance especially at low temperatures.
4. Fully automatic, semi automatic or manual operation of the system.

The advantages claimed for this system in which lubricant is forced progressively through each feed line until all bearings are serviced, thus assuring a measured quantity of lubricant each time the system is cycled, include:

1. Low cost investment protection.
2. Extended life of operating parts, with minimum wear.
3. Minimum down-time loss.
4. Low cost inspection and maintenance.
5. Reduction in hazard to personnel.
6. Reduction in the time required for re-lubrication to just a few seconds.
7. Product spoilage and wasted lubricant virtually eliminated.

Service performance records accumulated over an extended period of time indicate attractive money-saving benefits. e.g. $22.50 per month per tractor in one case. A saving of $104,904.00 annually on steel mill bearings, plus a 40 per cent reduction in power consumption. Repairs reduced by $45,000.00 annually on 26 fire brick presses. $75,000.00 saved annually on coal mining stripping shovels. These records exemplify the value of a permanently installed system which in addition to producing lower operating costs, assures greater protection to both equipment and operating personnel. (*Digested by A. F. Brewer*)

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* Not included in this issue.

CORRECTION

In the paper "Recent Developments in the Lubrication of Heavy Duty Industrial Gearing" by G. P. Maurer, published in the September issue, one word was omitted in error. On page 363 under PERFORMANCE CHARACTERISTICS OF LEAD NAPHTHENATE BASE LUBRICANTS the viscosity of lead naphthenates should *not* be less than 500 ssu at 210 F for ambient temperatures of 40 F to 100 F.

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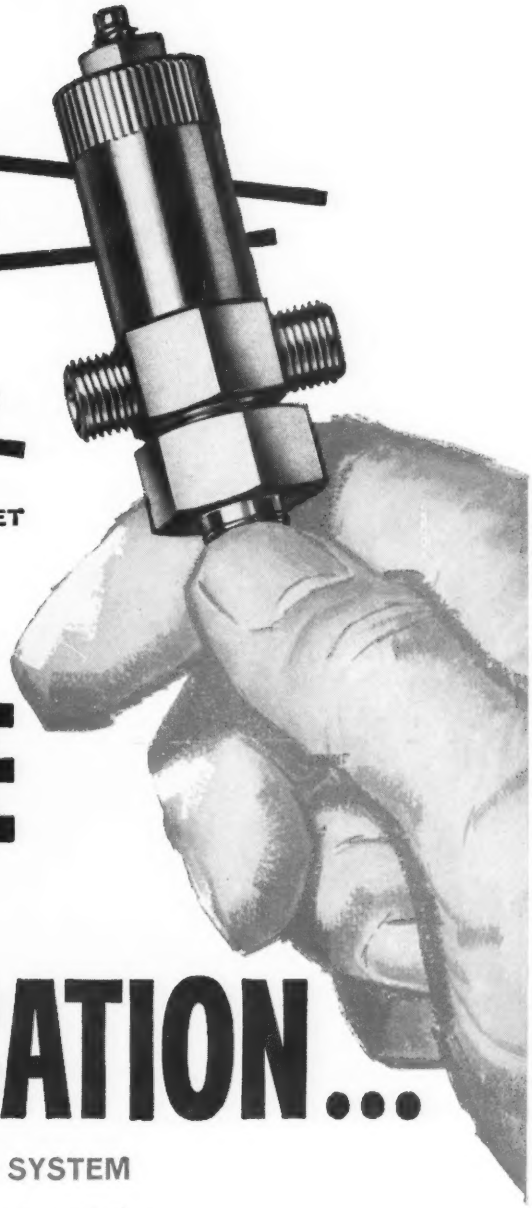

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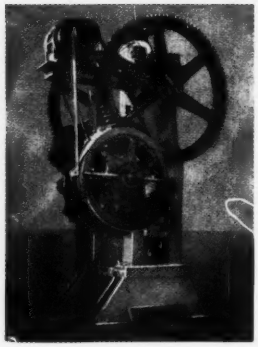

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Bevel gearing of tables in billet and bar mills.
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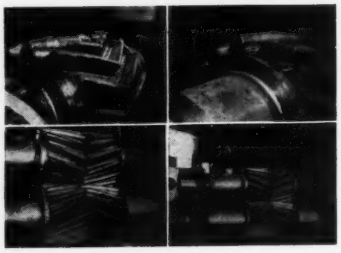

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